A LIMITED ENERGY STUDY OF HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS AT FORT STEWART AND HUNTER ARMY AIRFIELD, GEORGIA

VOLUME II
APPENDICES

FINAL SUBMITTAL

Prepared For
Savannah District, Corps of Engineers

Contract Number DACA01-94-D-0038
Delivery Order Number 0002

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September 6, 1996

6941331002

Forces Command	3rd Infantry Division Fort Stewart	Savannah District Corps of Engineers	Reynolds, Smith and Hills, Inc.

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A.1 SCOPE OF WORK

APPENDIX A
for Delivery Order No. 2,

A LIMITED ENERGY STUDY OF HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS AT FORT STEWART AND HUNTER ARMY AIRFIELD, GA

1. <u>BRIEF DESCRIPTION OF WORK</u>:
The Architect-Engineer (A-E) shall perform the following:

1.1 <u>Field Investigation.</u>

1.1.1 <u>High Temperature Water (HTW) Distribution Systems.</u> Develop a plan for and conduct a field survey to identify points or areas in the HTW distribution system at Fort Stewart where energy leaks occur, describe and estimate the cost of the Energy Conservation Opportunities (ECO's) to close these leaks in the most technically sound and cost-effective manner for the long-term, and perform a Life Cycle Cost Analysis (LCCA) to determine whether any or all of the recommended ECO's qualify for funding under the criteria for the Federal Energy Management Program (FEMP) or the Energy Conservation Investment Program (ECIP). At Hunter Army Airfield (HAAF) the A-E will review all available data and records for both the Central Energy Plant (CEP) and the pinwheel barracks energy plant and interview all personnel that the Fort Stewart Energy Officer (FSEO) can direct him to. Based on an analysis of the gathered information, the A-E will recommend whether or not further study of the HAAF HTW distribution systems should be programmed for the future.

1.1.2 <u>Chilled Water (CHW) Distribution Systems.</u> Review all data and records related to the Fort Stewart CHW distribution system and interview all personnel that the FSEO can direct him to. Based on this review, the A-E will make a recommendation as to whether or not a field investigation of the CHW system is needed. For HAAF the A-E will review all available records and data for both the CEP and and the pinwheel barracks energy plant and interview all personnel that the FSEO can direct him to. Based on an analysis of the gathered information, the A-E will recommend whether or not further study of the HAAF CHW distribution systems should be programmed for the future.

1.2 <u>Project Identification and Documentation.</u> The A-E is instructed to fully analyze and document one particular alternative for the Fort Stewart HTW distribution system: complete replacement of the existing distribution lines with a shallow trench distribution system. Other alternatives or projects will be identified by the A-E or government reviewers as a result of the study, and the A-E will provide complete programming or implementation documentation for all recommended projects, which may be individual ECO's or more than one ECO combined. Guidance from the participants in this project from Fort Stewart and Forces

Command (FORSCOM) will be given to the A-E at the interim submittal review stage as to how best to package ECO's for funding purposes.

1.3 Study Report. Provide a comprehensive report to document all work performed, the results and conclusions, and all recommendations.

2. SPECIFIC INSTRUCTIONS:

2.1 Field Investigation.

2.1.1 Plan for the field investigation. Prior to beginning any detailed system investigations at Fort Stewart, the A-E will be required to develop and submit for the other project team members' information a plan of action for the actual field work. As a minimum, it will include a weekly schedule of anticipated events, the techniques that will be used for surveying underground distribution lines, and a map annotated to depict the plan of attack for surveying the full length of all distribution lines and other distribution system components from the points of departure out of the Central Energy Plant (CEP) to the points of connection to each facility that is an end user of the energy supplied by the plant. In order to accomplish this, the A-E will be required to visit the intallation and:

2.1.1.1 Obtain a complete set of distribution system maps for Fort Stewart and HAAF. These will be annotated in the field during the detailed survey of the distribution systems. All inaccuracies or changes that are noted will be posted to the field maps. These annotated maps will be part of the interim submittal.

2.1.1.2 Review records of work orders and service orders, obtainable from the Resource Management Divisions and/or the Facilities Engineering Divisions at the respective installations, for the most recent twelve month period. This will assist the A-E in defining the areas most suspected of having energy leaks, where he may need to concentrate more of his field effort.

2.1.1.3 Interview personnel assigned to both Fort Stewart and HAAF most knowledgeable about the distribution systems, starting with the responsible division chiefs and proceeding through the organizational chain of command to the line workers responsible for operation, maintenance, and repair of the systems.

2.1.1.4 Review logs of make-up water volumes at the CEP. This study is directed to the correction of energy losses in the distribution system. Some investigation of equipment in the central plant and in the buildings served by the system may be necessary to aportion makeup water uasge among the distribution system, the CEP, and the building mechanical rooms. Sufficient field time should be devoted to these areas to gather the needed information.

2.1.2 Field survey.

2.1.2.1 The A-E will send sufficient personnel to the installations to complete the detailed field survey in the least amount of time possible. Contractor-developed forms designed to speed the process of conducting the field survey and contractor-controlled equipment and vehicles shall be available in adequate numbers to insure that the field crew(s) are never deadlined.

2.1.2.2 There will be a field survey manager appointed who will serve as the on site point of contact, who will be fully knowledgeable of the previous planning effort for the field survey, and who will serve in this capacity from beginning to end of the field survey. This individual will be required to report to the FSEO, or his project manager at the Savannah District, on a weekly basis. The field manager will have the authority to make those decisions necessary to finish the work in a thorough, high quality, and timely manner.

2.1.2.3 There are several non-destructive inspection techniques that can be employed to gather the information to pinpoint the sections in the systems where insulation has deteriorated to the degree that hot or cold spots are apparent, where water under pressure is leaking from lines or other parts of the system to include equipment in above ground components such as valve pits, or where energy losses in the system are occuring for other reasons. These include visual inspection, flow metering, infrared thermography, ground penetrating radar, SF6 leak detection, and video inspection. Other techniques with which the Contractor may have more familiarity or the technology for which has more recently been developed will be acceptable if they will produce the desired results and if they are identified in the plan for the field survey. The A-E will be responsible for the timing and coordination of the inspections and any peculiar requirements of a particular type and will be required to have his own equipment with which to perform the inspections by whatever technique(s) he chooses. The A-E will also be responsible for insuring that all safety standards are followed.

2.2 Project Identification and Documentation. All assumptions, formulas, input and output values, and the actual calculations used in generating project cost estimates and savings will be included with each ECO. All energy conservation opportunities or projects which the A-E has considered shall be included in one of the following categories and presented in the report as such:

2.2.1 Federal Energy Management Program (FEMP) Projects: Every attempt will be made to keep all projects within the Installation Commander's funding approval authorities applicable to the Operations and Maintenance, Army (OMA) account. These limitations are generally $300,000 for a project classified as construction and $1,000,000 for projects classified as maintenance

or repair, as defined in reference 9.2 and modified by reference 9.10. There is a special source of OMA funding called the FEMP that can generally provide funding for energy savings type projects, the cost of which are estimated to fall below these limitations, on a one year cycle or less, if a project is properly justified. To be classified as an OMA Energy maintenance or repair project, the project must result in needed maintenance or repair to an existing facility or replace a failed or failing system or component and result in energy savings. If the project would replace a system or component that is considered failed or failing due solely to obsolete technology or inefficiency, the system or component to be replaced must have been in use for at least three years and the simple payback period must be ten years or less. So long as the work can be logically separated and identified, projects can be combined in one undertaking. Any recommended project must have, as a minimum, a Savings to Investment Ratio (SIR) of 1.25 and a simple payback period of 10 years or less. The documentation required for each project is the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA (i.e., energy and non-energy savings calculations and cost estimate), the SIR, and the simple payback period. The documentation of these projects will be a part of the study report described below.

2.2.2 Energy Conservation Investment Program (ECIP) Projects. If a project cost estimate is greater than the limitations mentioned above, then the project becomes an ECIP project by definition. An ECIP project is one that proposes new construction or a retrofit of an existing facility for the purpose of conserving energy. In an ECIP project, savings may come from energy, demand, operations and maintenance, other factors, or a combination of the above. In addition to the cost threshhold, a project must also have an SIR greater than 1.25 and a simple payback period of less than ten years to meet the minimum criteria for ECIP projects. Where ECO's have been combined into one ECIP project, each discrete part must meet the SIR and simple payback criteria. Programming documentation shall consist of a DD Form 1391 and an LCCA summary sheet with necessary backup data to verify the numbers presented. An LCCA summary sheet shall be developed for each ECO and for the overall project when more than one ECO have been combined.

2.2.3 Low Cost/No Cost Projects. These are projects which the DPW can complete using his in-house work force. Minimum documentation will consist of a description of the project, a sketch of the location and the work required, a rationale for why the project is recommended, and a cost estimate. Other project documentation requirements may be added by the FSEO.

2.2.4 Nonfeasible ECO's. All ECO's which the A-E has considered but which are not feasible shall be documented in the report with reasons and justifications showing why they were rejected.

2.3 Study Report. The work accomplished shall be fully documented by a comprehensive report. While the cost of report production is certainly a consideration, the report submittals must be well organized and lend themselves to quick and easy review because the installation staff will have only limited time available for this. The A-E is expected to compile the information for the submittals in a logical sequence and must take great care to consider the reader's point of view. Spelling, grammar, and punctuation will be checked prior to making a submittal; and, for clarity, highly technical terms will be explained. Before making copies for each submittal, the report will be proofread and critiqued by an employee of the firm not familiar with the project to insure good readability. Just as important as any other part of the effort, the A-E must be concise in conveying the key information to the customer. Following these rules will help to insure that the A-E's credibility will not suffer and that his technical capabilities will not be questioned.

The interim submittal may be copied and bound in the most convenient and least expensive manner, so long as it meets the criteria above. The pre-final report will be organized, tabbed, copied, and bound in the exact manner which the A-E proposes to produce the final report. Review of both submittals will include comments on the report's organization and flow of thought. The final report will incorporate all earlier comments and, if the pre-final report is produced properly, will be produced by page for page replacement in or page addition to the pre-final report. A high quality 3-ring binder will be used to package the pre-final report.

For easy reading line length on the printed page is a consideration. It may be adviseable to use a two column format to accomplish this. The pages of the original copy will be laser printed. Xeroxed copies on high quality paper are acceptable so long as there is essentially no discernible difference between them and the original. A title page will be inserted in a sleeve on the front cover and will contain a photograph descriptive of the report contents. The inside title page will also incorporate logos and credits to the A-E and the offices which have played a role in development of the study and report, particularly the installation. This will be followed by a table of contents. Each section, subsection, and appendix shall be separated by a thick paper divider tabbed with the section name and number. Each page will be numbered with a section number followed by a dash and a page number.

A separately bound Executive Summary of the study, giving a brief overview of the conclusions and recommendations using graphs, tables, and charts as much as possible, will be prepared as part of the final submittal. For clarity, color will be used in these graphic elements or any others that appear in the report. The body of the report itself--i.e., that portion where the technical analysis, conclusions, and recommendations are developed--shall be organized in a logical manner and written simply enough for a person not an expert in the field to follow the line of reasoning for each project. All project documentation will be presented in this portion of the report. Appendices will include as a minimum

the Scope of Work for this D.O., minutes of meetings, and survey forms. Any other appendices that the A-E thinks will assist in making the report better and more organized are also encouraged. If acronyms are used, there will be a list of each one used with a definition.

3. SERVICES AND MATERIALS: All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor (including that required to research installation records or databases to obtain all information needed to perform a thorough study), equipment, supervision, and travel necessary to complete the work and render the data required under this D.O. are to be included in the lump sum price.

4. GENERAL:

4.1 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study. The A-E is encouraged to use his specialized knowledge in this field to provide additional information which will help the installation justify energy improvement projects.

4.2 For the distribution systems described above all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All systems improvements that are considered during the study will be documented in the report, including those that are rejected because they are considered infeasible with reasons given for elimination. If, under another set of assumptions, an infeasible project will become feasible, then so state. For example, if using in-house labor to perform work would be less costly than using contract labor, and this change would result in meeting the SIR and payback criteria, then document this.

4.3 The "Energy Conservation Investment Program (ECIP) Guidance," described in a letter from DAIM-FDF-U, dated 10 Jan 1994, and any subsequent revisions establish criteria for ECIP projects and shall be used for performing the economic analyses associated with these projects. The software program, Life Cycle Cost in Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer. The LCCID program is available from the BLAST Support Office at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61901 for a nominal fee. The telephone number is (217) 333-3977 or (800) 842-5278.

4.4 The A-E shall take great care to insure that the FSEO is kept apprised of the ongoing work, either directly or through periodic contact with his Savannah District project manager. The final recommended projects will be both technically and economically feasible and will be acceptable to the FSEO.

4.5 Public Disclosures. The A-E shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

4.6 Meetings. Meetings will be scheduled whenever requested by the A-E or the government's representative acting for the installation project manager for the resolution of questions or problems encountered in the performance of the work. These meetings, if necessary, will be in addition to the scheduled review meetings and presentations.

4.7 Site Visits, Inspections, and Investigations. The Contractor shall visit and inspect/investigate the site of the projects as necessary and required during the preparation and accomplishment of the work. Visits will be coordinated with the FSEO at least a week in advance. The A-E will determine whether any special security clearances are required with the assistance of the FSEO.

4.8 All invoices or payment estimates (ENG Form 93) will be sent to the Savannah District project manager, who is identifed below in paragraph 5.4, for review and approval.

4.9 <u>Records.</u>

4.9.1 The A-E shall provide a record of all significnt conferences, meetings, discussions, verbal directions, telephone conversations, etc., with government personnel relative to this project in which the A-E has participated. These records shall be dated and shall identify the contract and D.O. number, participating personnel, subject discussed, and conclusions reached. The A-E shall forward by letter to the list of P.O.C.'s in paragraph 5 within ten calendar days of the event a reproducible copy of the records. These will also be included in the study report as an appendix.

4.9.2 The A-E should expect to provide the manpower needed for, and should base his fee proposal on, gathering all information himself required to complete the study. But, if the A-E faces a situation where he must request the installation's assistance, then he shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this D.O. The records shall be dated and shall identify the contract and D.O. number. The A-E shall forward to the Savannah District project manager within ten calendar days a reproducible copy of the record

of request or receipt of material.

4.10 Briefings. The A-E and the Savannah District project manager shall conduct entry and exit interviews with the DPW, or his designated representative as instructed by the FSEO, before starting work at the installation and after completion of the study.

4.10.1 Entry. The entry interview shall describe the purpose of the study, the intended procedures for the survey, the schedule, names of personnel performing the field investigation and the A-E's project manager, support required by the A-E of the DPW staff, a description of the final products, and any other information the A-E wishes to communicate and shall be conducted prior to commencing work at the installation.

4.10.2 Exit. The exit interview shall describe the items surveyed, an assessment of the condition of existing systems, and the results and conclusions of the analysis.

5. PROJECT MANAGEMENT:

5.1 The A-E shall designate a project manager, in addition to the field survey manager mentioned above, who will serve as the primary P.O.C. and liaison for work required under this D.O. If the A-E chooses, the same person can serve in both capacities but must be on site throughout the field survey. Upon award of this D.O., the individual shall be immediately designated in writing. The A-E's designated project manager shall be approved by the Contracting Officer prior to commencement of work. The project manager will be responsible for coordination of work required under this D.O. The A-E's project manager shall submit monthly progress reports, typically in conjunction with pay requests, and shall telephonically update the Savannah District project manager on project events about every two weeks between pay requests. Immediately upon award of this D.O., the A-E's project manager will submit a project schedule substituting dates for calendar days, with an assumed 28 calendar day government review period after each submittal.

5.2 The Fort Stewart Energy Officer and installation project manager for this effort is Doug Swanson, telephone number (912) 767-7925, FAX number (912) 767-9779. He will assist the A-E in obtaining information and establishing contacts necessary to accomplish the work required under this D.O.

5.3 The U.S. Forces Command program manager is Naresh Kapur, telephone number (404) 669-5327, FAX number (404) 669-7751.

5.4 The U.S. Army Corps of Engineers, Savannah District, project manager is Rob Callahan, telephone number (912) 652-5246, FAX number (912) 652-5442.

5.5 The U.S. Army Corps of Engineers, Savannah District, Contracting Officers Representative is Tom Clarke, telephone number (912) 652-5364, FAX number (912) 652-5090.

5.6 The U.S. Army Corps of Engineers, Mobile District, is the Army's designated Technical Center of Expertise for the Energy Engineering Analysis Program. Mobile District's program manager is Tony Battaglia, telephone number (205) 690-2618, FAX number (205) 690-2424.

6. SUBMITTALS, PRESENTATIONS, AND REVIEWS:

6.1 Interim Report Submittal. An interim report, which will include all field notes, shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECO's. The report shall indicate the work which has been accomplished to date, ilustrate the methods and justifications of the approaches taken and contain a plan for the work remaining to complete the study. One copy of the interim report shall be submitted for review to the FORSCOM and Mobile District P.O.C.'s. Two copies of the report shall be submitted to the Fort Stewart and Savannah District P.O.C.'s. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECO's shall be included. The results of the ECO analyses shall be summarized by lists as follows:

6.1.1 All ECO's eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in paragraph 2.2.4.

6.1.2 All ECO's which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order of descending SIR. These lists may be subdivided by location or area as appropriate for the study.

6.1.3 The A-E shall make a presentation of the report at a review conference. Visual aids or other methods of presentation will be at the A-E's discretion to make understanding by those present easier.

6.2 Pre-final Report Submittal. The A-E shall prepare and submit the pre-final report when he believes all work under this D.O. is essentially complete. The report will be formatted and bound exactly as the A-E proposes to format the final report. All project documentation shall be completed and included in the report. All comments resulting from review of the interim submittal or from the presentation shall have been addressed in compiling this report, and review action comments related to the interim report shall be included in a separate appendix keyed to sections of the pre-final report where the appropriate changes have been made. The same number of copies shall be sent to the same offices as specified above for the interim report.

6.3 Final Report. Any revisions or corrections resulting from comments made during the review of the pre-final report will be able to be incorporated by page for page replacement in or page addition to the pre-final report, if it has been produced in accordance with these instructions. All instructions on organization and formatting shall be strictly followed. A separately bound Executive Summary will be prepared, as described above in paragraph 2.3. One copy each of the final submittal shall be sent to the FORSCOM and Mobile District P.O.C.'s; two copies each shall be sent to the Savannah District P.O.C.; and three copies, along with the original, shall be sent to the Fort Stewart P.O.C. In addition one copy each of only the Executive Summary shall be sent to the Corps of Engineers, South Atlantic Division, P.O.C., the U.S. Army Logistics Evaluation Agency P.O.C., and to the HQUSACE P.O.C. listed below in paragraph 8.

7. PROJECT SCHEDULE:

Milestone	Date
Entry interview and begin gathering information	NLT 14 days after award of this D.O.
A-E submits recommendations on further studies and field survey plan	NLT 42 days after award of this D.O.
A-E begins field survey	As described in field survey plan
A-E completes field survey	As described in field survey plan
A-E submits interim report	NLT 154 days after completion of field survey
Interim submittal review meeting and presentation	NLT 7 days after completion of government review
A-E submits pre-final report	NLT 56 days after interim submittal review meeting
A-E submits final report	NLT 28 days after receipt of government review comments on pre-final
Exit briefing	NLT 14 days after submitting final report

8. <u>POINTS OF CONTACT</u>:

Commander
24th Infantry Division and Fort Stewart
ATTN: AFZP-DEV ~~(Mr. Doug Swanson)~~ (Mr. Tim Harper)
Fort Stewart, GA 31314

Commander
U.S. Army Forces Command
ATTN: AFPI-ENO (Mr. Naresh Kapur)
Fort McPherson, GA 30330

Savannah District, Corps of Engineers
ATTN: CESAS-PM-MR (Mr. Rob Callahan)
100 W. Oglethorpe Avenue
P.O. Box 889
Savannah, GA 31402-0889

Mobile District, Corps of Engineers
ATTN: CESAM-EN-DM (Mr. Tony Battaglia)
P.O. Box 2288
Mobile, AL 36628-0001

Commander
U.S. Army Engineer Division, South Atlantic
ATTN: CESAD-EN-TE (Mr. Baggette)
77 Forsyth Street, SW
Atlanta, GA 30335-6801

Commander
U.S. Army Corps of Engineers
ATTN: CEMP-ET (Mr. Gentil)
20 Massachusetts Avenue, NW
Washington, DC 20314-1000

Commander
U.S. Army Logistics Evaluation Agency
ATTN: LOEA-PL (Mr. Keath)
New Cumberland Army Depot
New Cumberland, PA 17070-5007

9. <u>REFERENCES</u>:

9.1 Architect and Engineer Instructions, 9 Dec 91

9.2 AR 420-10, Management of Installation Directorates of Engineering and Housing, 2 Jul 87

9.3 AR 415-15 (DRAFT), Army Military Construction Program Development and Execution

9.4 Energy Conservation Investment Program (ECIP) Guidance, 10 Jan 94

9.5 TM 5-785, Engineering Weather Data

9.6 TM 5-800-4, Programming Cost Estimates for Military Construction, Feb 94

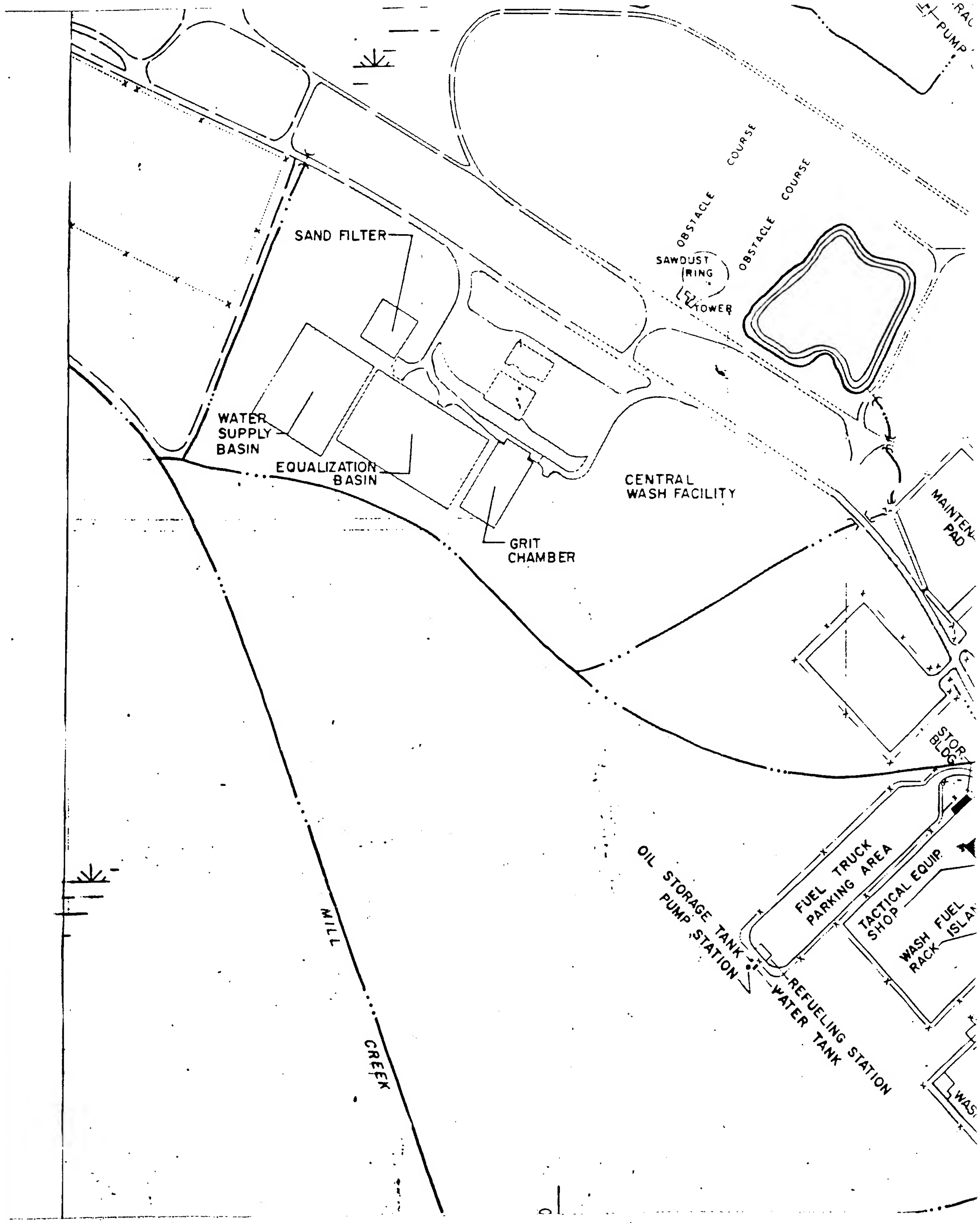
9.7 General Energy Conservation Opportunities

9.8 Required DD Form 1391 Data

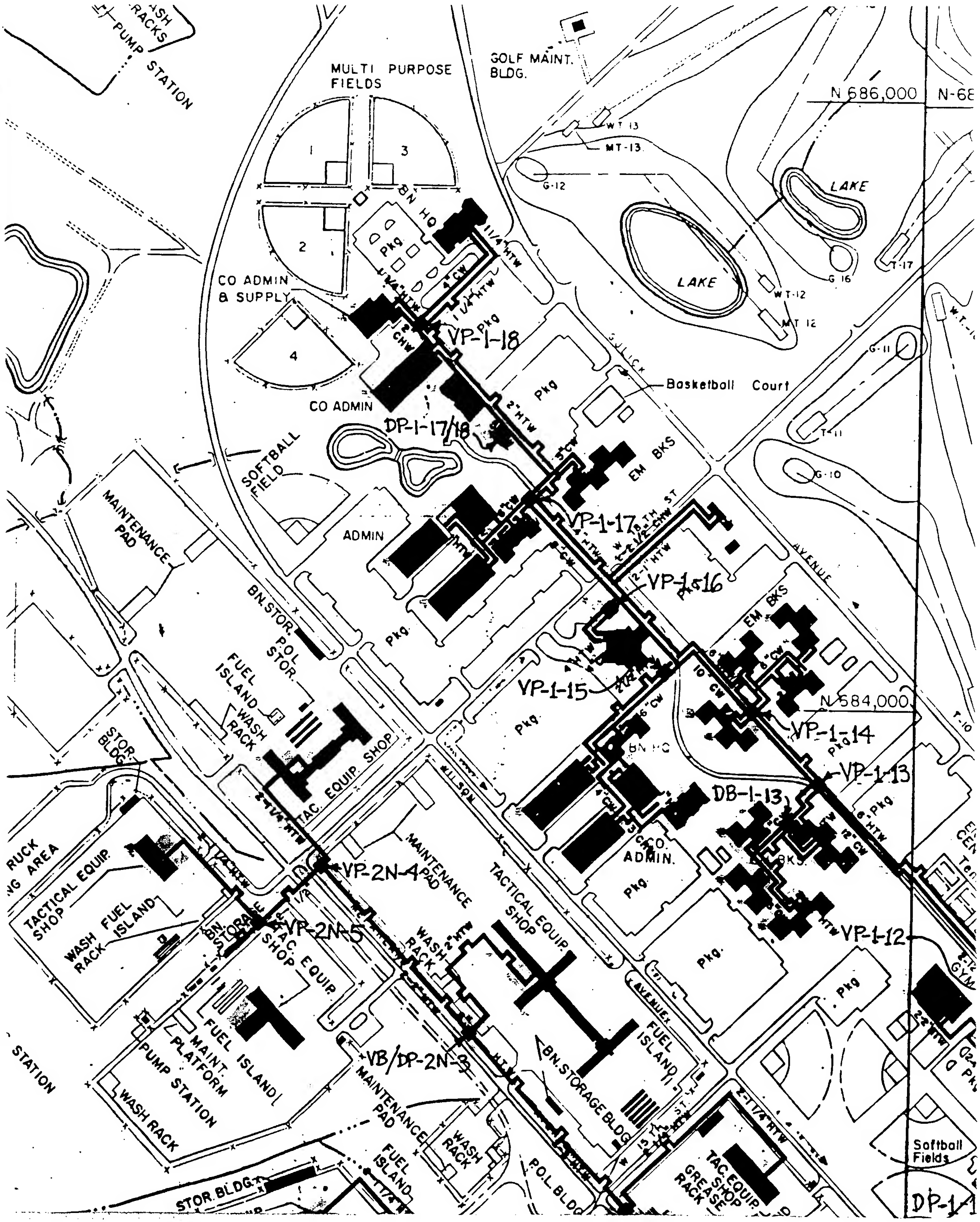
9.9 AR 11-27, Army Energy Program, 14 Jul 89

9.10 TWX dated 111600Z Jul 94 from DAIM-FDF-B, subject: Future Change to AR 420-10

A.2 HTW DISTRIBUTION SYSTEM MAP



PUMP
OBSTACLE COURSE
OBSTACLE COURSE
SAWDUST RING
TOWER
SAND FILTER
WATER SUPPLY BASIN
EQUALIZATION BASIN
GRIT CHAMBER
CENTRAL WASH FACILITY
MAINTEN. PAD
STOR. BLDG.
FUEL TRUCK PARKING AREA
TACTICAL EQUIP. SHOP
WASH RACK
FUEL ISLAN
OIL STORAGE TANK PUMP STATION
REFUELING STATION
WATER TANK
MILL CREEK


MULTI PURPOSE FIELDS
GOLF MAINT. BLDG.
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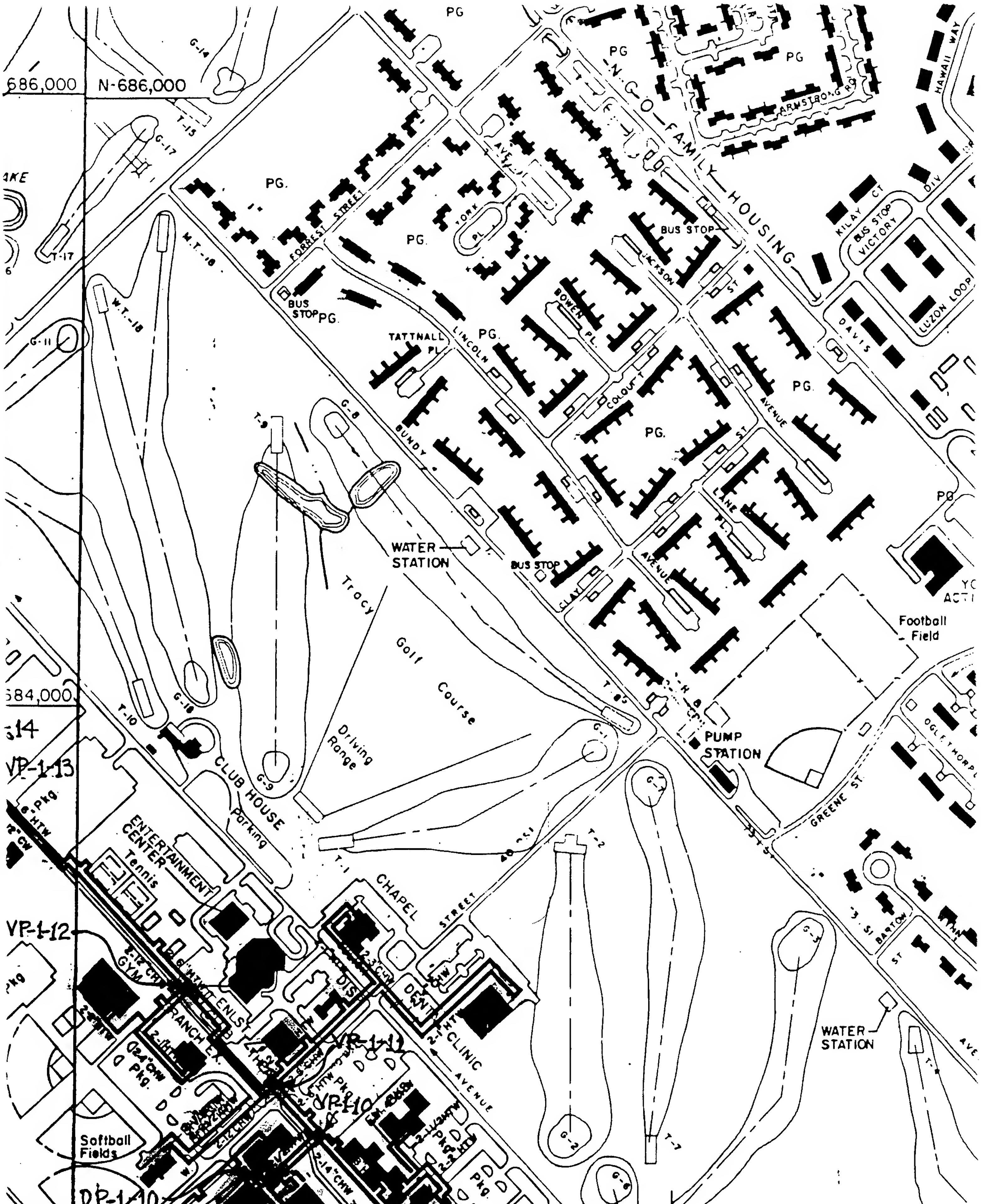
PUMP STATION
WASH RACKS
LAKE
LAKE
BN HQ
CO ADMIN & SUPPLY
VP-1-18
CO ADMIN
DP-1-17/18
Basketball Court
EM BKS
SOFTBALL FIELD
MAINTENANCE PAD
ADMIN
VP-1-17
VP-1-16
BN. STOR.
POL STOR.
FUEL ISLAND
WASH RACK
TAC. EQUIP. SHOP
VP-1-15
EM BKS
N 584,000
VP-1-14
BN HQ
VP-1-13
DB-1-13
CO. ADMIN.
BKS
STOR BLDG.
TACTICAL EQUIP SHOP
WASH RACK
FUEL ISLAND
VP-2N-4
VP-2N-5
MAINTENANCE PAD
TACTICAL EQUIP SHOP
TAC. EQUIP SHOP
VP-1-12
GYM
WASH RACK
FUEL ISLAND
MAINT. PLATFORM
PUMP STATION
WASH RACK
STATION
VB/DP-2N-3
MAINTENANCE PAD
BN. STORAGE BLDG
FUEL ISLAND
WASH RACK
POL BLDG
TAC. EQUIP. SHOP GREASE RACK
STOR. BLDG.
Softball Fields
DP-1-1



N-686,000
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PG
N.C.O. FAMILY HOUSING
ARMSTRONG RD
HAWAII WAY
FORREST STREET
YORK PL
BUS STOP
JACKSON
BOWEN PL
TATTNALL PL
LINCOLN
COLQUITT
AVENUE
KILAY CT
VICTORY
LUZON LOOP
DAVIS
DIV
BUNDY
ST
LANE PL
CLAY
WATER STATION
Tracy Golf Course
Driving Range
Football Field
PUMP STATION
GREENE ST
OGLETHORPE
CLUB HOUSE
Parking
ENTERTAINMENT CENTER
Tennis
CHAPEL STREET
CLINIC
AVENUE
GYM
DIS
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Pkg.
Pkg
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VP-1-12
VP-1-11
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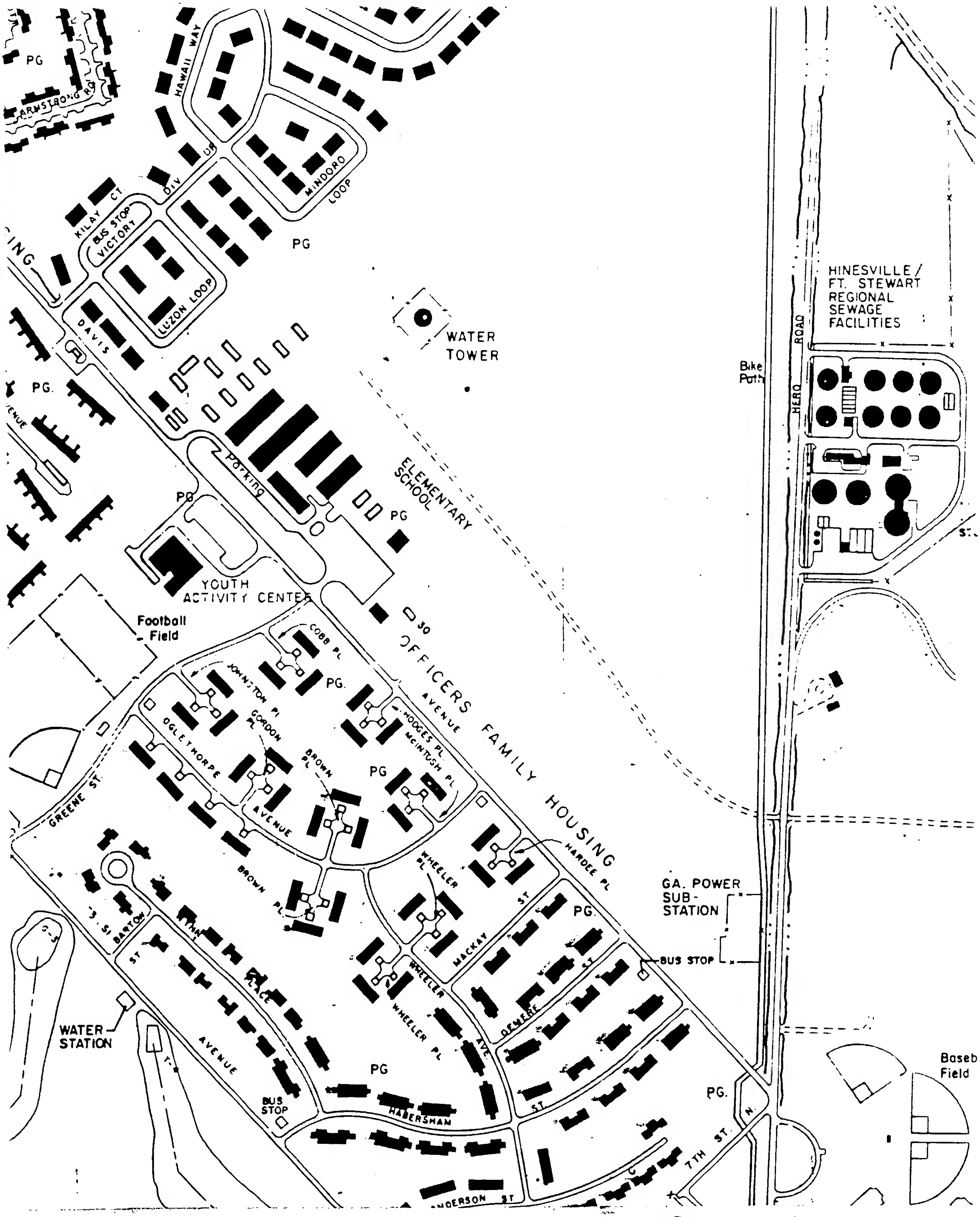
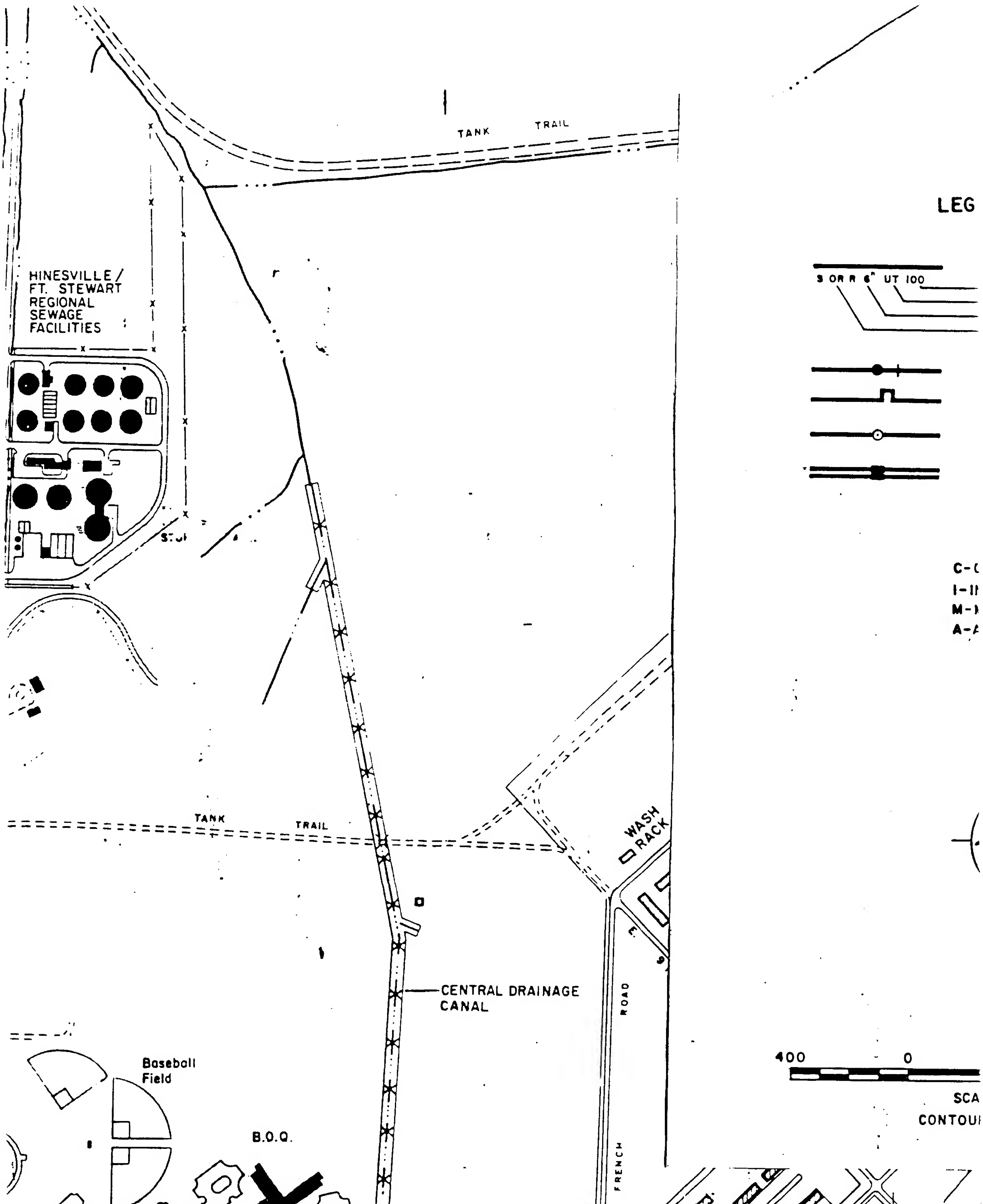
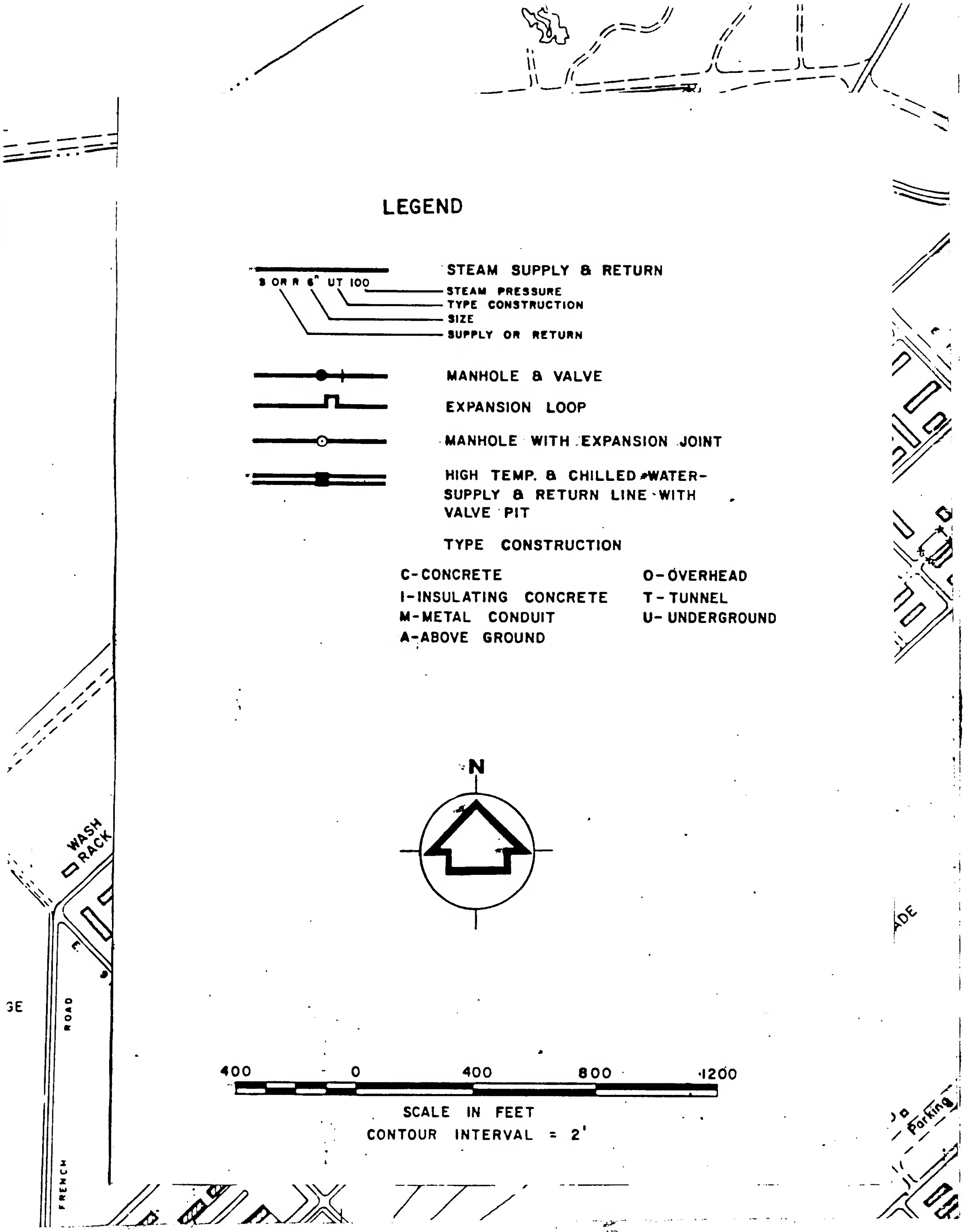
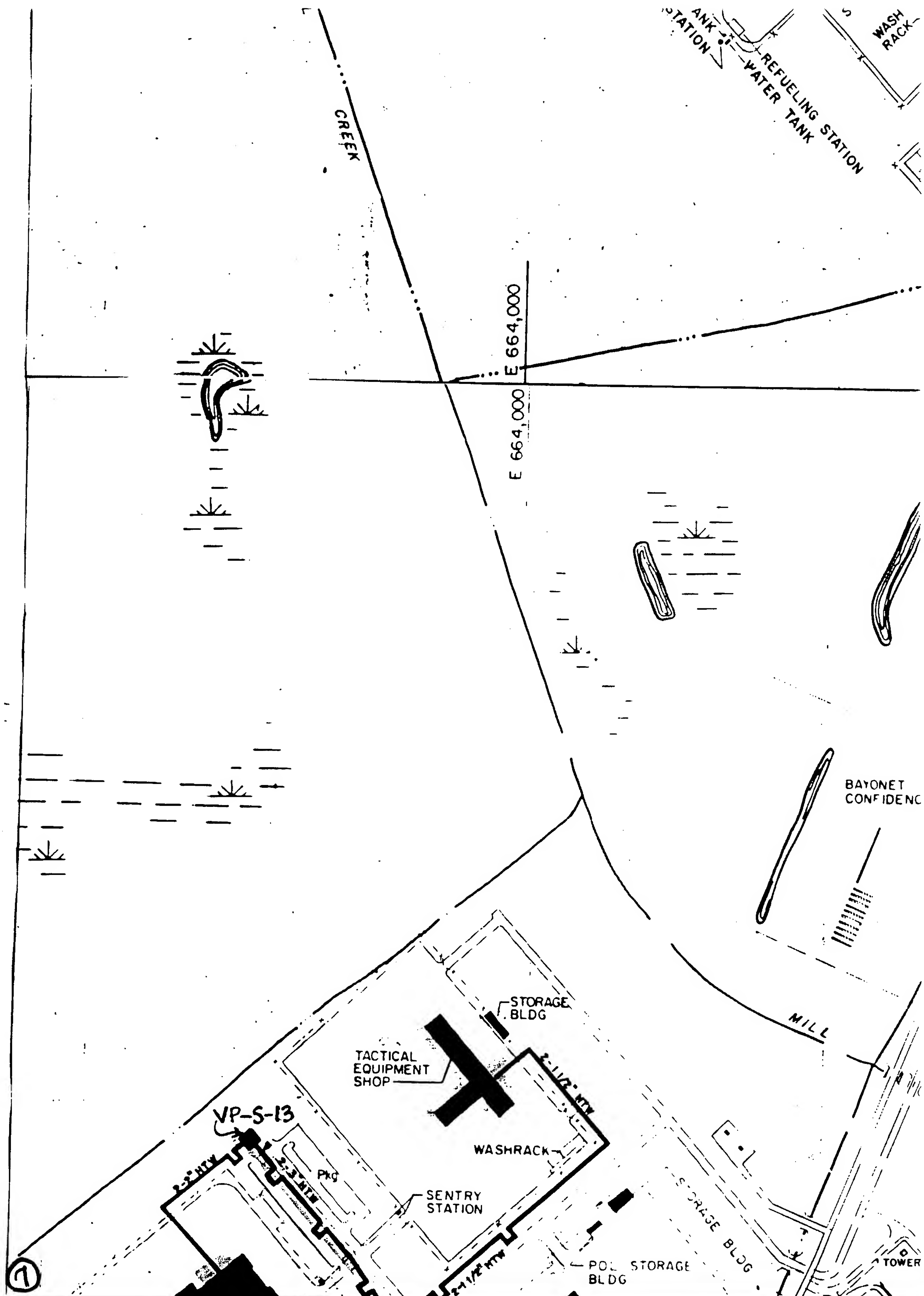


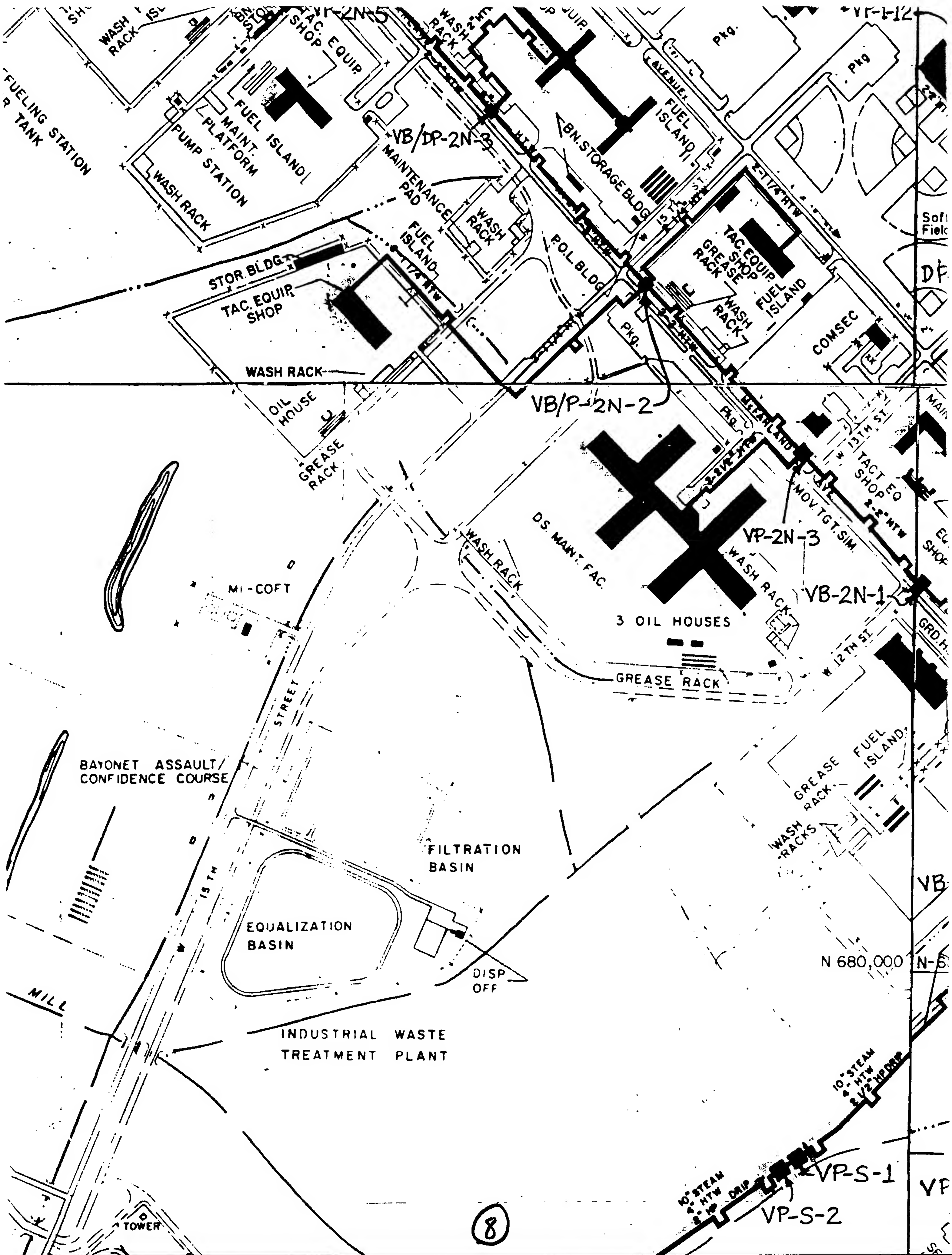
PG
ARMSTRONG PL
HAWAII WAY
MINDORO LOOP
DIV DR
KILAY CT
BUS STOP
VICTORY
LUZON LOOP
DAVIS
PG
WATER TOWER
HINESVILLE / FT. STEWART REGIONAL SEWAGE FACILITIES
HERO ROAD
Bike Path
Parking
ELEMENTARY SCHOOL
YOUTH ACTIVITY CENTER
Football Field
30
OFFICERS FAMILY HOUSING
COBB PL
JOHNSTON PL
GORDON PL
OGLETHORPE AVENUE
HODGES PL
MCINTOSH PL
BROWN PL
GREENE ST.
HARDEE PL
WHEELER PL
MACKAY ST
GA. POWER SUB-STATION
BUS STOP
BARTOW ST
LYNN PLACE
DEMERE ST
WHEELER AVE.
WATER STATION
AVENUE
BUS STOP
HABERSHAM
ANDERSON ST
7TH ST. N.
Baseb. Field

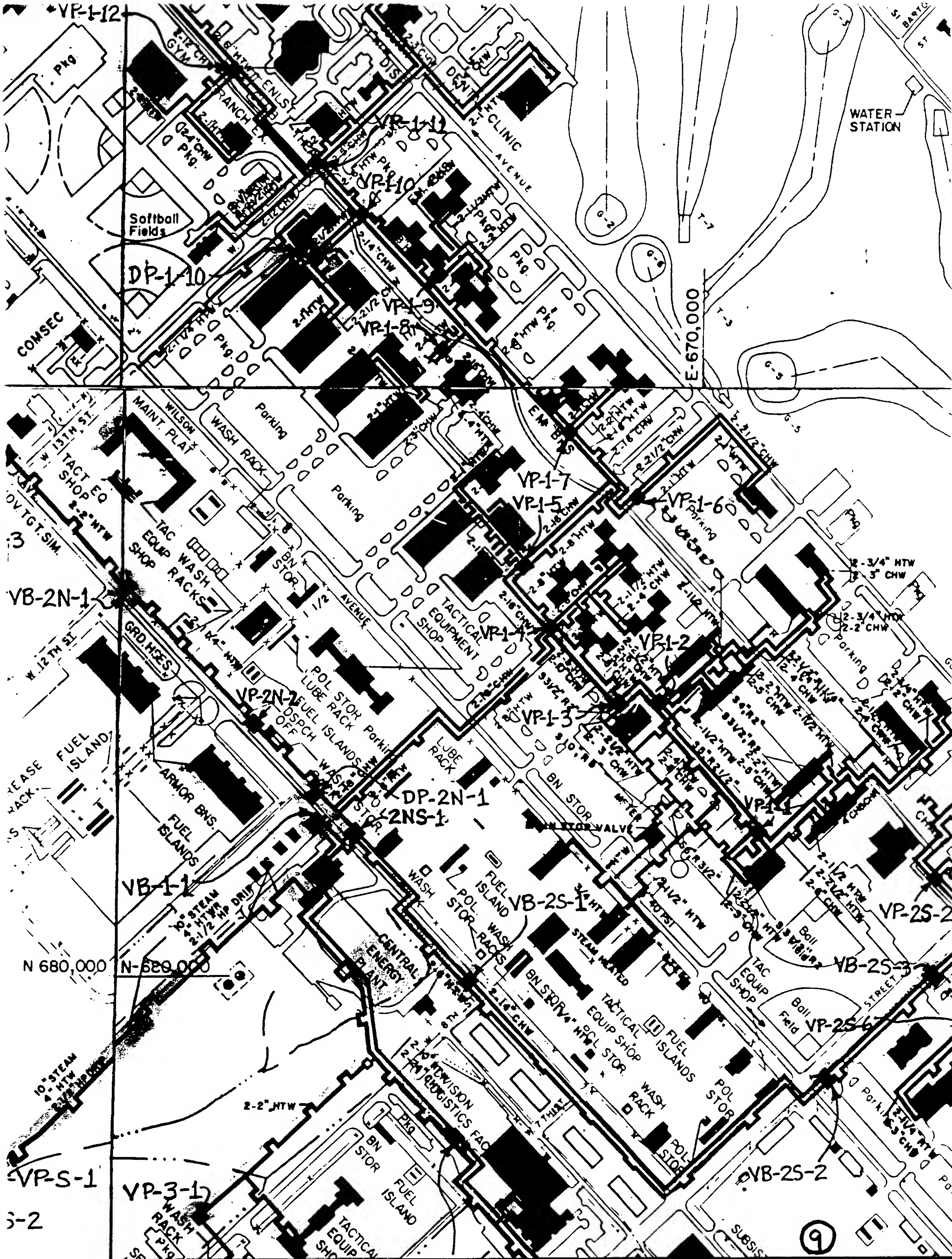

TANK TRAIL
HINESVILLE / FT. STEWART REGIONAL SEWAGE FACILITIES
TANK TRAIL
WASH RACK
CENTRAL DRAINAGE CANAL
Baseball Field
B.O.Q.
FRENCH ROAD
LEG
S OR R 6" UT 100
400
0
SCA
CONTOU

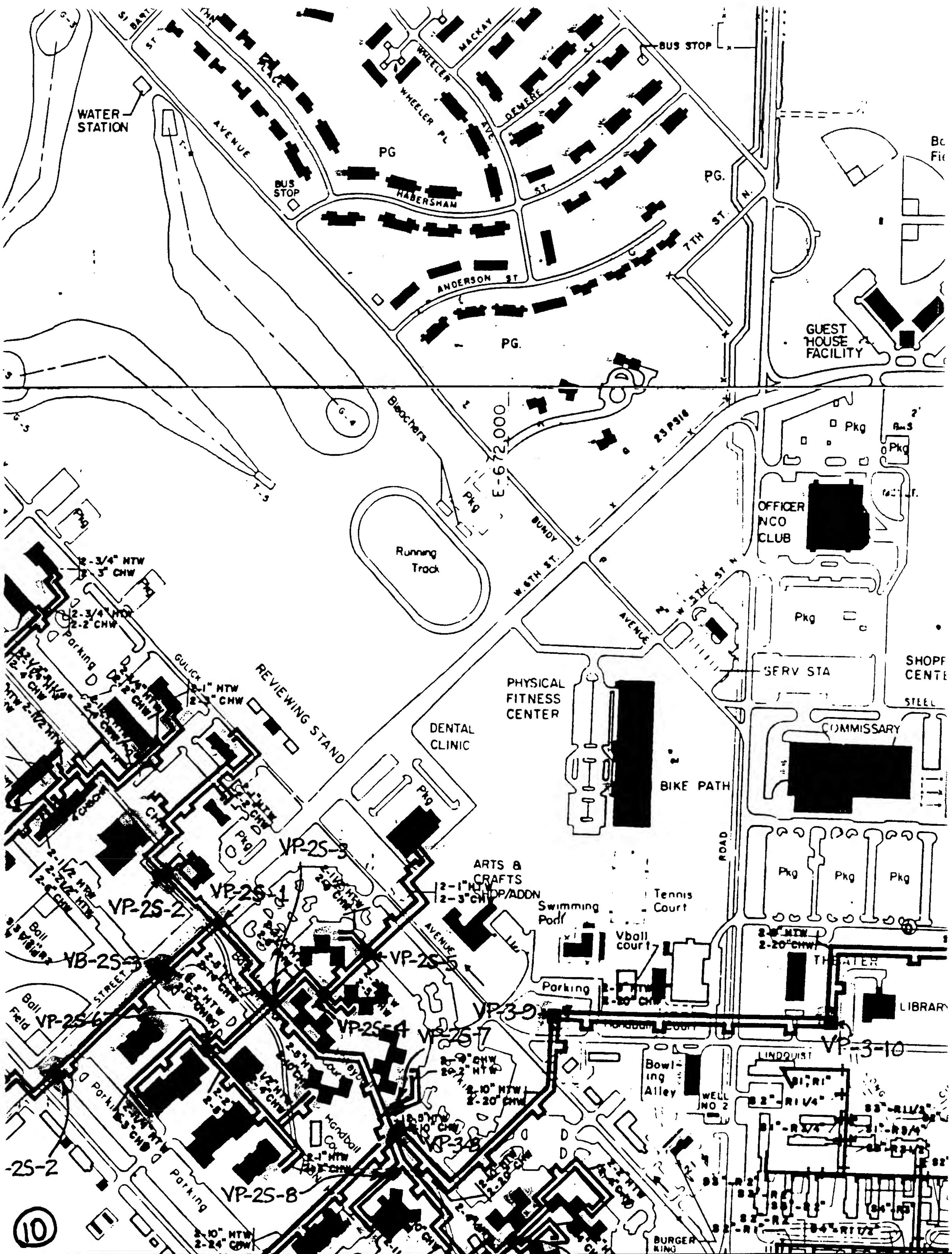

LEGEND
STEAM SUPPLY & RETURN
S OR R 6" UT 100
STEAM PRESSURE
TYPE CONSTRUCTION
SIZE
SUPPLY OR RETURN
MANHOLE & VALVE
EXPANSION LOOP
MANHOLE WITH EXPANSION JOINT
HIGH TEMP. & CHILLED WATER-SUPPLY & RETURN LINE WITH VALVE PIT
TYPE CONSTRUCTION
C-CONCRETE
I-INSULATING CONCRETE
M-METAL CONDUIT
A-ABOVE GROUND
O-OVERHEAD
T-TUNNEL
U-UNDERGROUND
N
400 0 400 800 1200
SCALE IN FEET
CONTOUR INTERVAL = 2'
WASH RACK
ROAD
FRENCH
Parking

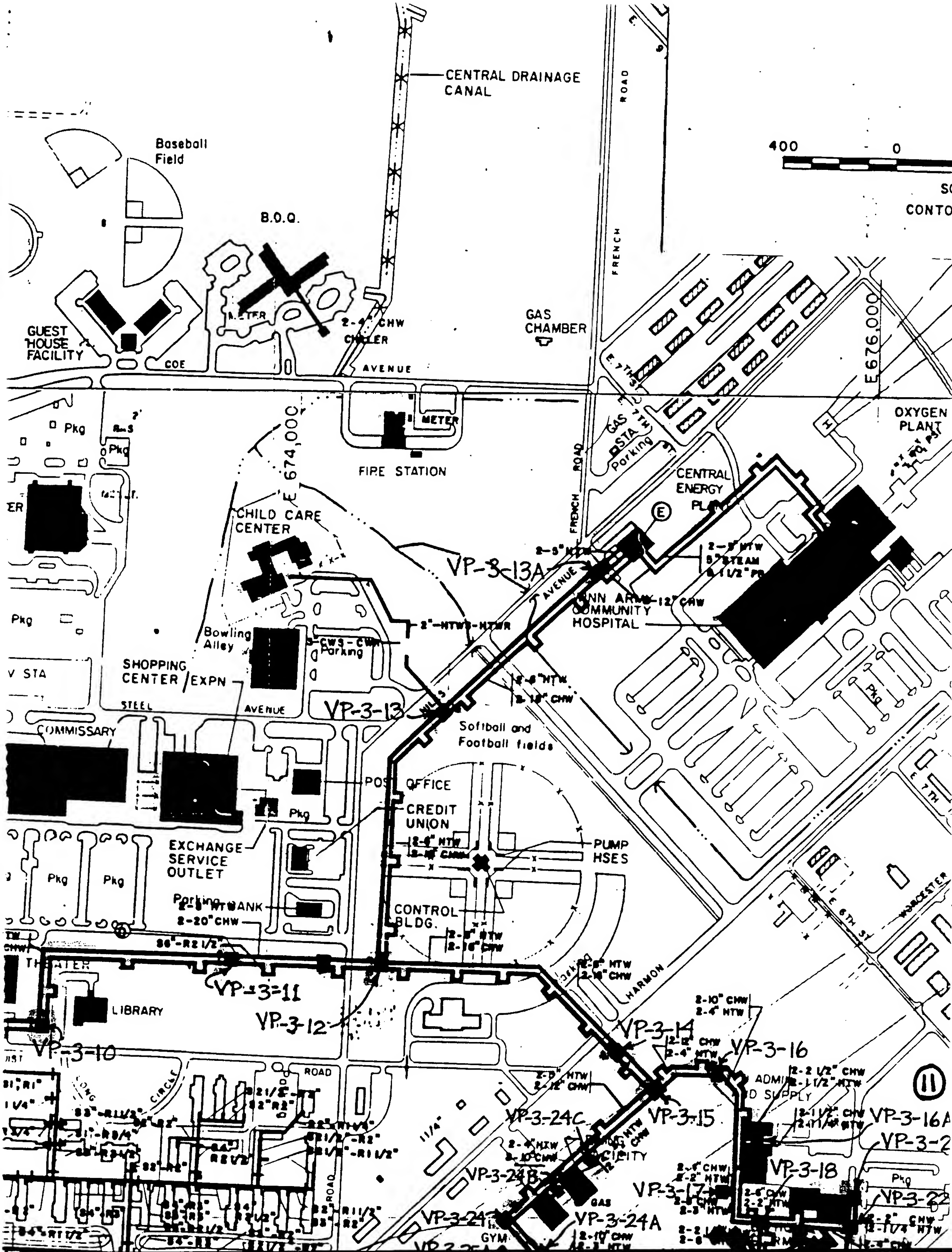


ANK STATION
REFUELING STATION
WATER TANK
WASH RACK
CREEK
E 664,000
E 664,000
BAYONET CONFIDENC
MILL
STORAGE BLDG
TACTICAL EQUIPMENT SHOP
VP-S-13
WASHRACK
SENTRY STATION
PKG
POL STORAGE BLDG
STORAGE BLDG
TOWER
7

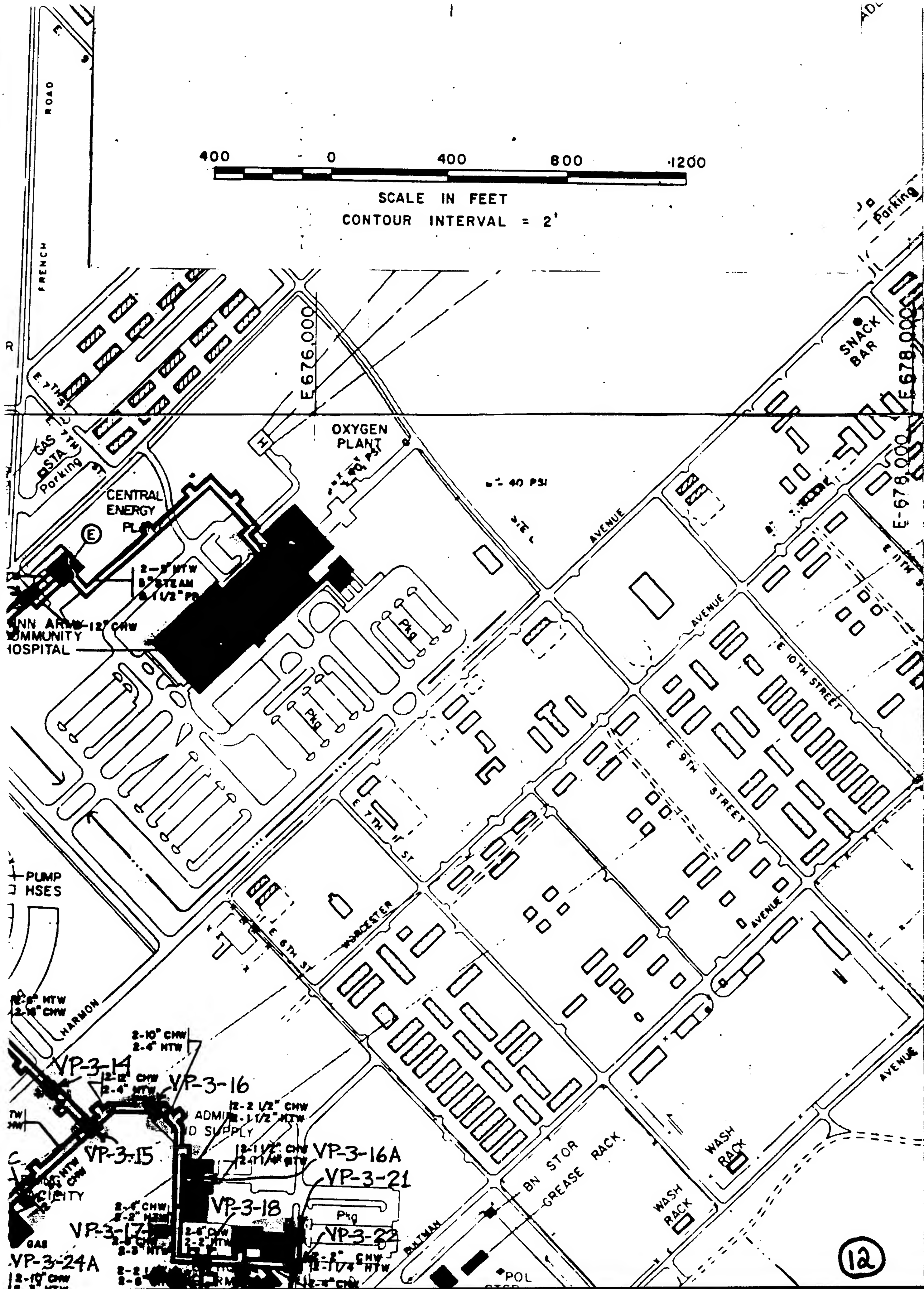

VP-2N-5
VP-1-12
WASH RACK
TAC. SHOP EQUIP
FUEL ISLAND
FUELING STATION
TANK
MAINT. PLATFORM
PUMP STATION
WASH RACK
VB/DP-2N-3
MAINTENANCE PAD
BN. STORAGE BLDG
FUEL ISLAND
AVENUE
Pkg.
Pkg
Soft Field
STOR. BLDG.
TAC. EQUIP. SHOP
FUEL ISLAND
1 1/4" HTW
WASH RACK
P.O.L. BLDG.
TAC EQUIP. SHOP
GREASE RACK
WASH RACK
FUEL ISLAND
15TH ST.
2-1 1/4" HTW
COMSEC
Pkg.
WASH RACK
OIL HOUSE
VB/P-2N-2
GREASE RACK
McFARLAND
W. 13TH ST.
TACT EQ SHOP
2-2" HTW
2-2 1/2" HTW
MOV. TGT. SIM.
VP-2N-3
DS. MAINT. FAC.
WASH RACK
WASH RACK
VB-2N-1
MI-COFT
3 OIL HOUSES
GRD. H
W. 12TH ST.
GREASE RACK
STREET
FUEL ISLAND
GREASE RACK
WASH RACKS
BAYONET ASSAULT/
CONFIDENCE COURSE
FILTRATION
BASIN
W. 15TH
EQUALIZATION
BASIN
N 680,000
DISP
OFF
MILL
INDUSTRIAL WASTE
TREATMENT PLANT
10" STEAM
4" HTW
2 1/2" HP DRIP
10" STEAM
4" HTW
2" HP DRIP
VP-S-1
VP-S-2
TOWER


VP-1-12
GYM
ENLST
BRANCH EX
DIS
DENT
CLINIC
AVENUE
WATER STATION
Pkg
Softball Fields
DP-1-10
VP-1-11
VP-1-10
VP-1-9
VP-1-8
COMSEC
E-670,000
WILSON
MAINT. PLAT
WASH RACK
Parking
W. 13TH ST.
TACT. EQ SHOP
TAC EQUIP SHOP
WASH RACKS
BN STOR
AVENUE
TACTICAL EQUIPMENT SHOP
VP-1-7
VP-1-5
VP-1-6
VP-1-4
VP-1-2
VP-1-3
VP-1-1
VB-2N-1
GRD. HSES.
W. 12TH ST.
VP-2N-2
POL STOR
LUBE RACK
FUEL ISLANDS
DSPCH OFF
WASH
FUEL ISLAND
GREASE RACK
ARMOR BNS.
FUEL ISLANDS
LUBE RACK
DP-2N-1
2NS-1
BN STOR
MAIN STOR VALVE
VB-1-1
10" STEAM
4" HTW
2-1/2" HP DRIP
N 680,000
N-680,000
CENTRAL ENERGY PLANT
WASH
POL STOR
FUEL ISLAND
WASH RACKS
VB-2S-1
STEAM HEATED
BN STOR
TACTICAL EQUIP SHOP
POL STOR
FUEL ISLANDS
WASH RACK
POL STOR
TAC EQUIP SHOP
Ball Field
STREET
VB-2S-3
VP-2S-6
VP-2S-2
12 - 3/4" HTW
12 - 3" CHW
2-2" HTW
DIVISION LOGISTICS FAC
BN STOR
Pkg
FUEL ISLAND
WASH RACK
TACTICAL EQUIP
VB-2S-2
VP-S-1
VP-3-1
SUBSIS
7 TH ST.

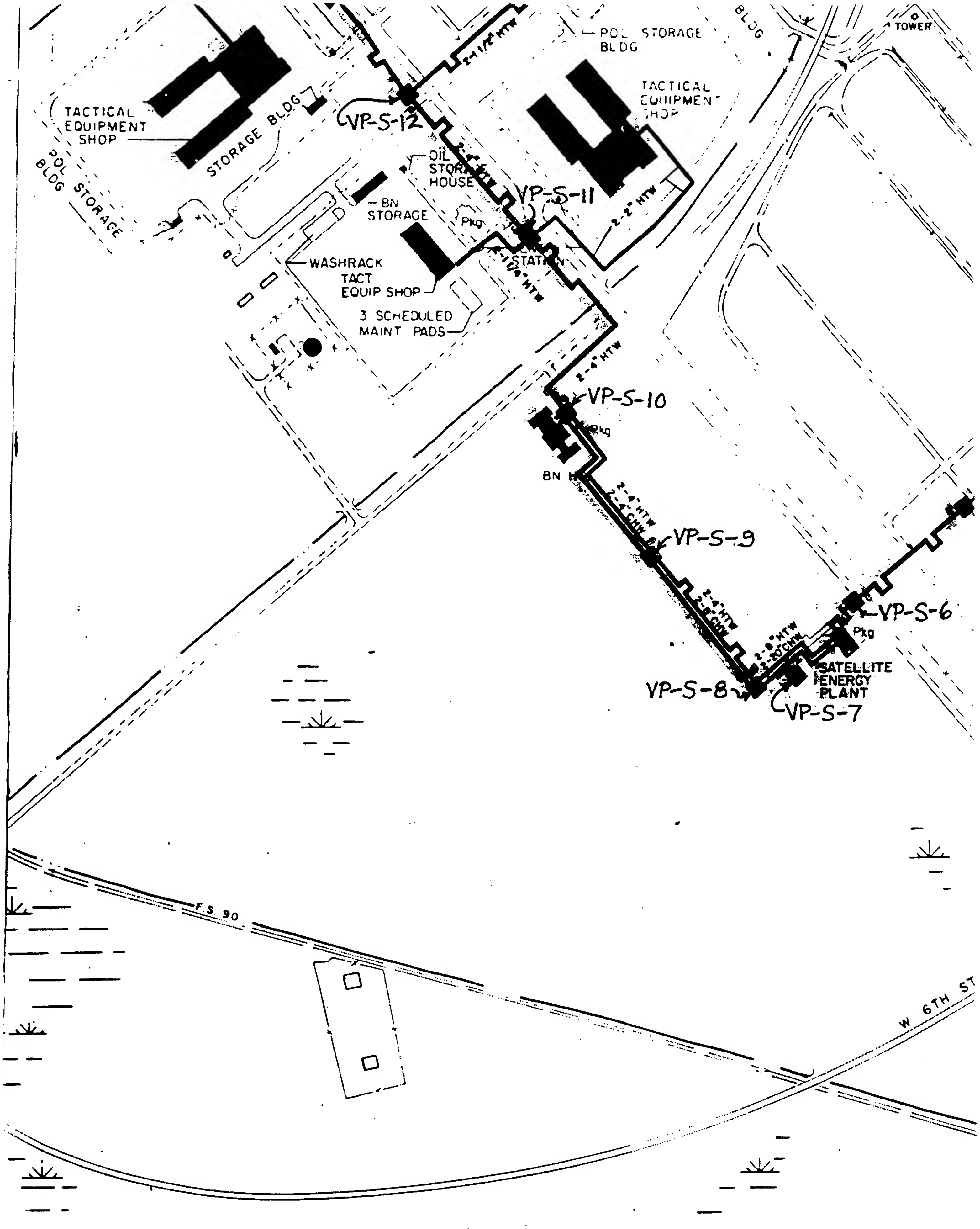

WATER STATION
ST
AVENUE
BUS STOP
PG
WHEELER
WHEELER PL
AVE
MACKAY
DEMERE
ST
HABERSHAM
BUS STOP
PG.
7TH ST. N.
ANDERSON ST
PG.
GUEST HOUSE FACILITY
Bleachers
E-672,000
23 PSI6
Pkg
Pkg
OFFICER NCO CLUB
Running Track
BUNDY
W. 6TH ST.
AVENUE
W. 5TH ST N
Pkg
SERV STA
SHOPP CENTE
STEEL
2-3/4" HTW
2-3" CHW
2-3/4" HOW
2-2" CHW
Parking
GULICK
2-1" HTW
2-3" CHW
REVIEWING STAND
PHYSICAL FITNESS CENTER
DENTAL CLINIC
Pkg
COMMISSARY
BIKE PATH
ROAD
Pkg
Pkg
Pkg
Pkg
VP-2S-3
VP-2S-1
VP-2S-2
ARTS & CRAFTS SHOP/ADDN
2-1" HTW
2-3" CHW
Swimming Pool
Tennis Court
Vball court
2-8" HTW
2-20" CHW
THEATER
VB-2S-3
VP-2S-5
AVENUE
STREET
Ball Field
VP-2S-6
Parking
VP-3-9
LIBRARY
VP-2S-4
VP-2S-7
VP-3-10
2-9" CHW
2-2" HTW
Bowling Alley
WELL NO 2
LINDQUIST
2-10" HTW
2-20" CHW
Handball Court
Parking
VP-3-8
-2S-2
Parking
VP-2S-8
2-1" HTW
2-10" HTW
2-24" CHW
BURGER KING

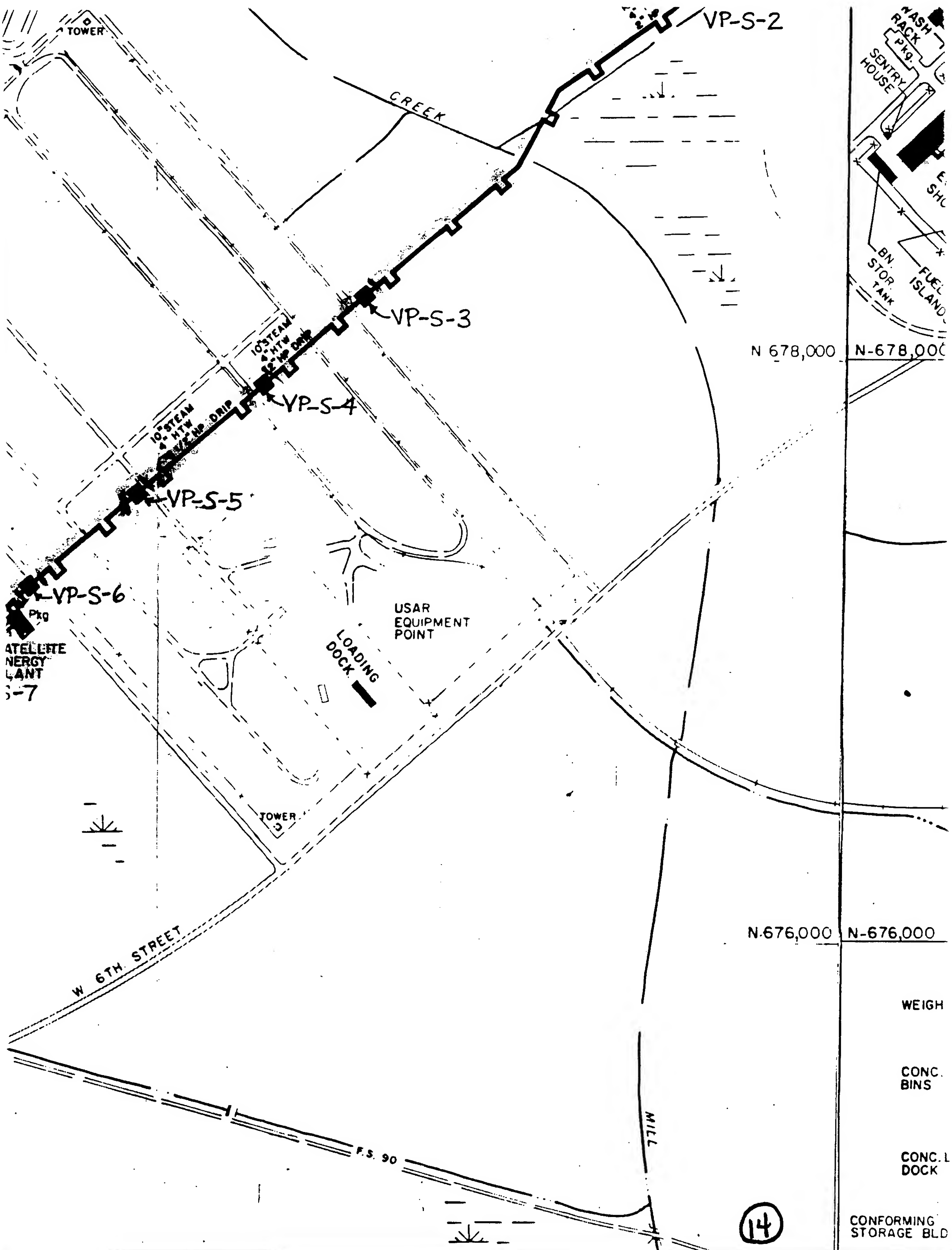


CENTRAL DRAINAGE CANAL
ROAD
400
0
SC
CONTO
Baseball Field
B.O.Q.
GUEST HOUSE FACILITY
COE
AVENUE
2-4" CHW
CHILLER
METER
GAS CHAMBER
FRENCH
E 676,000
OXYGEN PLANT
E 674,000
FIRE STATION
GAS STA
Parking
CENTRAL ENERGY PLANT
CHILD CARE CENTER
VP-3-13A
2-5" HTW
5" STEAM
12" CHW
COMMUNITY HOSPITAL
Bowling Alley
2"-HTWS-HTWR
Parking
SHOPPING CENTER / EXPN
STEEL
AVENUE
VP-3-13
Softball and Football fields
2-6" HTW
2-10" CHW
Pkg
COMMISSARY
POST OFFICE
CREDIT UNION
EXCHANGE SERVICE OUTLET
PUMP HSES
Parking
BANK
2-20" CHW
CONTROL BLDG.
2-8" HTW
2-16" CHW
THEATER
LIBRARY
VP-3=11
VP-3-12
HARMON
2-10" CHW
2-4" HTW
VP-3-14
VP-3-16
VP-3-10
ROAD
CIRCLE
2-12" CHW
VP-3-15
ADMIN
SUPPLY
VP-3-24C
VP-3-16A
VP-3-2
VP-3-24B
VP-3-18
VP-3-17
VP-3-22
VP-3-24
VP-3-24A
GYM
GAS
2-10" CHW
E 6TH ST
WORCESTER
E 7TH ST
11

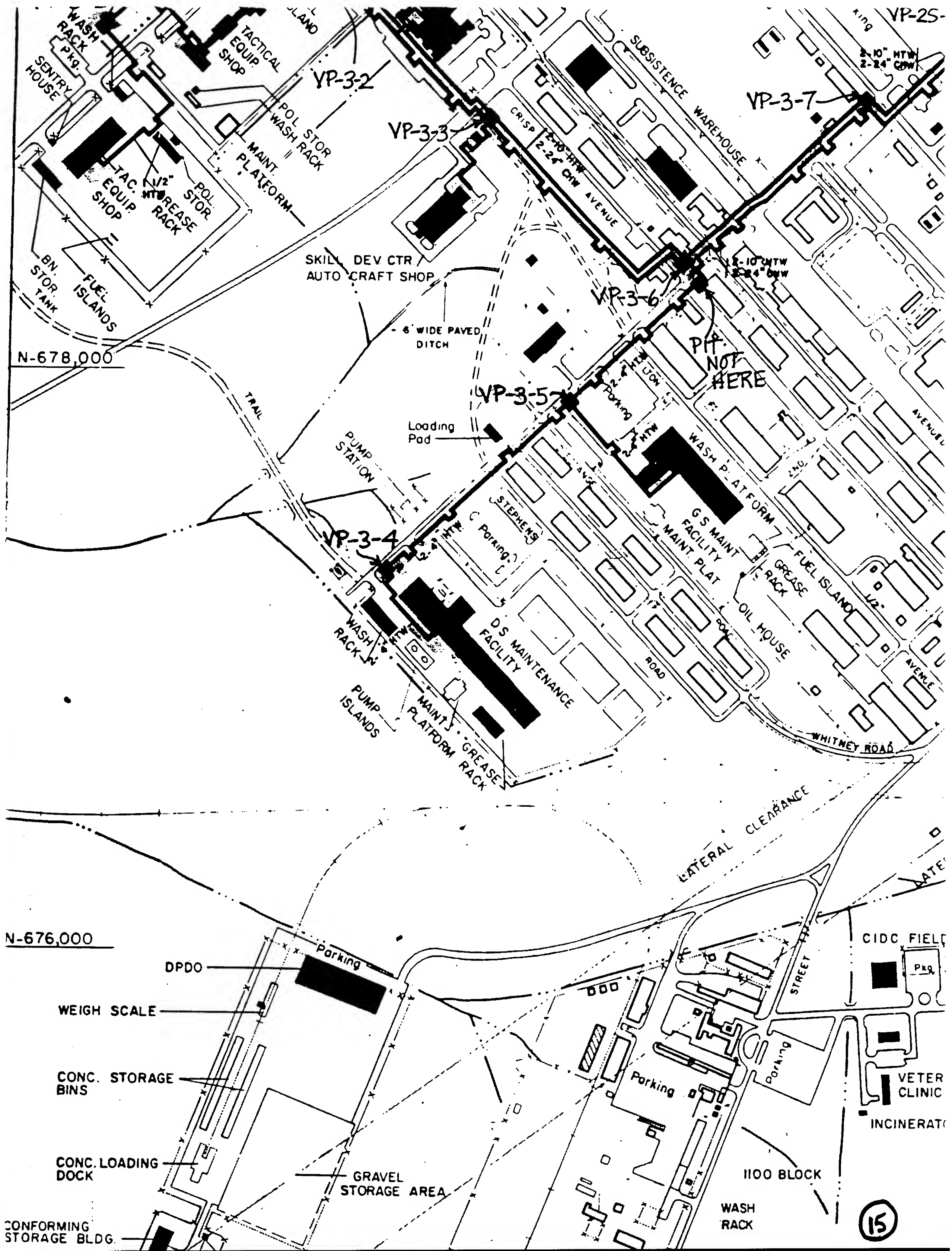


400 0 400 800 1200
SCALE IN FEET
CONTOUR INTERVAL = 2'
FRENCH ROAD
E 676,000
E 678,000
OXYGEN PLANT
CENTRAL ENERGY PLANT
SNACK BAR
GAS STA
Parking
2-5" HTW
8" STEAM
1 1/2" PR
12" CHW
COMMUNITY HOSPITAL
Pkg
AVENUE
E 10TH STREET
E 9TH STREET
E 7TH ST
E 6TH ST
E 11TH ST
WORCESTER
HARMON
PUMP HSES
VP-3-14
VP-3-15
VP-3-16
VP-3-16A
VP-3-17
VP-3-18
VP-3-21
VP-3-22
VP-3-24A
2-10" CHW
2-4" HTW
BN STOR
GREASE RACK
WASH RACK
PULLMAN
POL

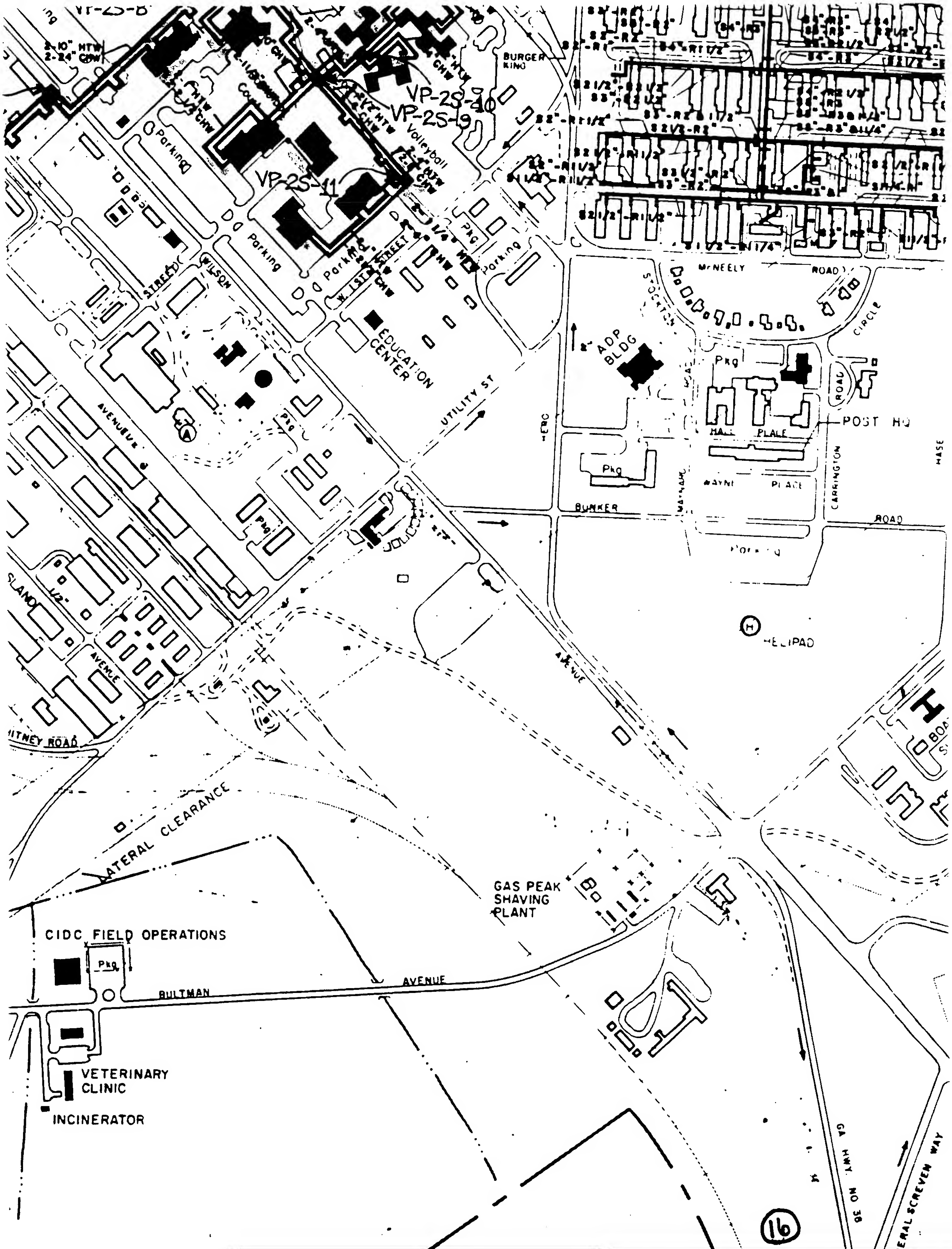

TACTICAL EQUIPMENT SHOP
STORAGE BLDG
POL STORAGE BLDG
VP-S-12
2-1 1/2" HTW
POL STORAGE BLDG
TACTICAL EQUIPMENT SHOP
TOWER
OIL STORAGE HOUSE
BN STORAGE
VP-S-11
2-2" HTW
Pkg
WASHRACK
TACT EQUIP SHOP
3 SCHEDULED MAINT PADS
2-4" HTW
VP-S-10
Pkg
BN
VP-S-9
VP-S-6
Pkg
SATELLITE ENERGY PLANT
VP-S-8
VP-S-7
F.S. 90
W 6TH ST

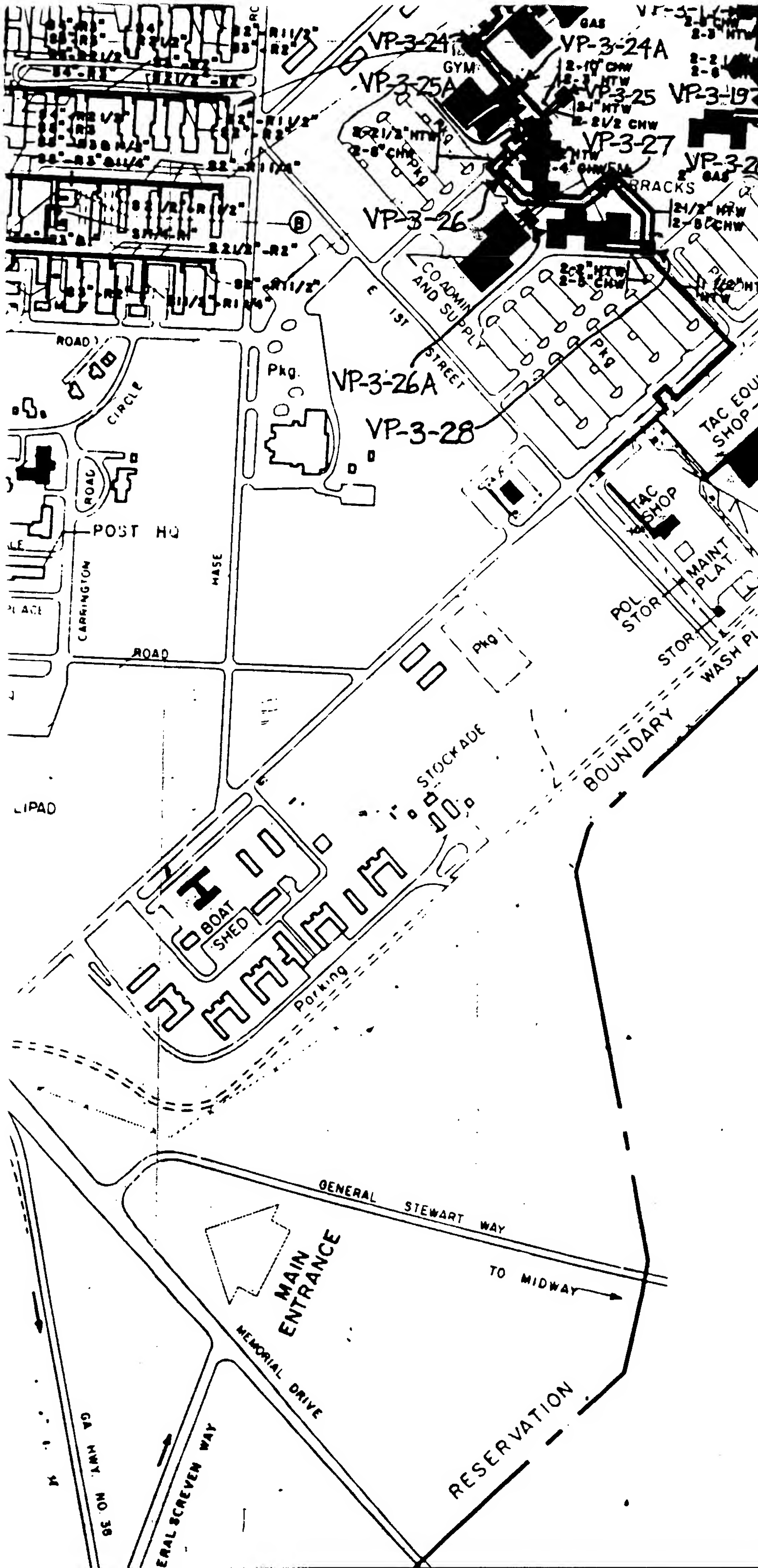


VP-S-2
TOWER
CREEK
WASH RACK
Pkg.
SENTRY HOUSE
BN. STOR TANK
FUEL ISLAND
VP-S-3
10" STEAM 4" HTW 1/2" HP DRIP
VP-S-4
10" STEAM 4" HTW 1/2" HP DRIP
VP-S-5
VP-S-6
Pkg
ATELLITE NERGY LANT
N 678,000
N-678,00
USAR EQUIPMENT POINT
LOADING DOCK
TOWER
N-676,000
N-676,000
W 6TH STREET
WEIGH
CONC. BINS
F.S. 90
MILL
CONC. DOCK
CONFORMING STORAGE BLD
14



VP-25-
WASH RACK
Pkg.
SENTRY HOUSE
TACTICAL EQUIP SHOP
POL STOR WASH RACK
MAINT PLATFORM
TAC. EQUIP. SHOP
1/2" HTW
GREASE RACK
POL STOR
BN. STOR TANK
FUEL ISLANDS
VP-3-2
VP-3-3
VP-3-4
VP-3-5
VP-3-6
VP-3-7
SUBSISTENCE WAREHOUSE
CRISP AVENUE
2-10" HTW
2-24" CHW
SKILL DEV. CTR / AUTO CRAFT SHOP
6' WIDE PAVED DITCH
N-678,000
TRAIL
PIT NOT HERE
Loading Pad
PUMP STATION
Parking
WASH PLATFORM
G S MAINT FACILITY
MAINT. PLAT
STEPHENS
GREASE RACK
FUEL ISLAND
OIL HOUSE
WASH RACK
PUMP ISLANDS
MAINT. PLATFORM
GREASE RACK
D S MAINTENANCE FACILITY
ROAD
WHITNEY ROAD
LATERAL CLEARANCE
N-676,000
DPDO
WEIGH SCALE
CONC. STORAGE BINS
CONC. LOADING DOCK
GRAVEL STORAGE AREA
CONFORMING STORAGE BLDG.
STREET
CIDC FIELD
Pkg.
VETER CLINIC
INCINERAT
1100 BLOCK
WASH RACK
15


2-10" HTW
2-24" CHW
BURGER KING
VP-2S-10
VP-2S-9
VP-2S-11
Volleyball
Parking
Parking
Parking
Parking
Parking
WILSON
STREET
W 1ST STREET
EDUCATION CENTER
UTILITY ST
AVENUE
Pkg
ADP BLDG
McNEELY
ROAD
STOCKTON
CIRCLE
Pkg
ROAD
POST HQ
HALL
PLACE
WAYNE
PLACE
CARRINGTON
Pkg
BUNKER
ROAD
Parking
HELIPAD
AVENUE
WHITNEY ROAD
AVENUE
LATERAL CLEARANCE
GAS PEAK
SHAVING
PLANT
CIDC FIELD OPERATIONS
Pkg
BULTMAN
AVENUE
VETERINARY
CLINIC
INCINERATOR
GA HWY NO 38
SCREVEN WAY



FORT STEWART

SURVEY

PHASE I - CEP, SEF

PHASE II - VALVE &

PHASE III - DISTRIBU
ZONE 1
ZONE 2
ZONE 3
SEP DIS

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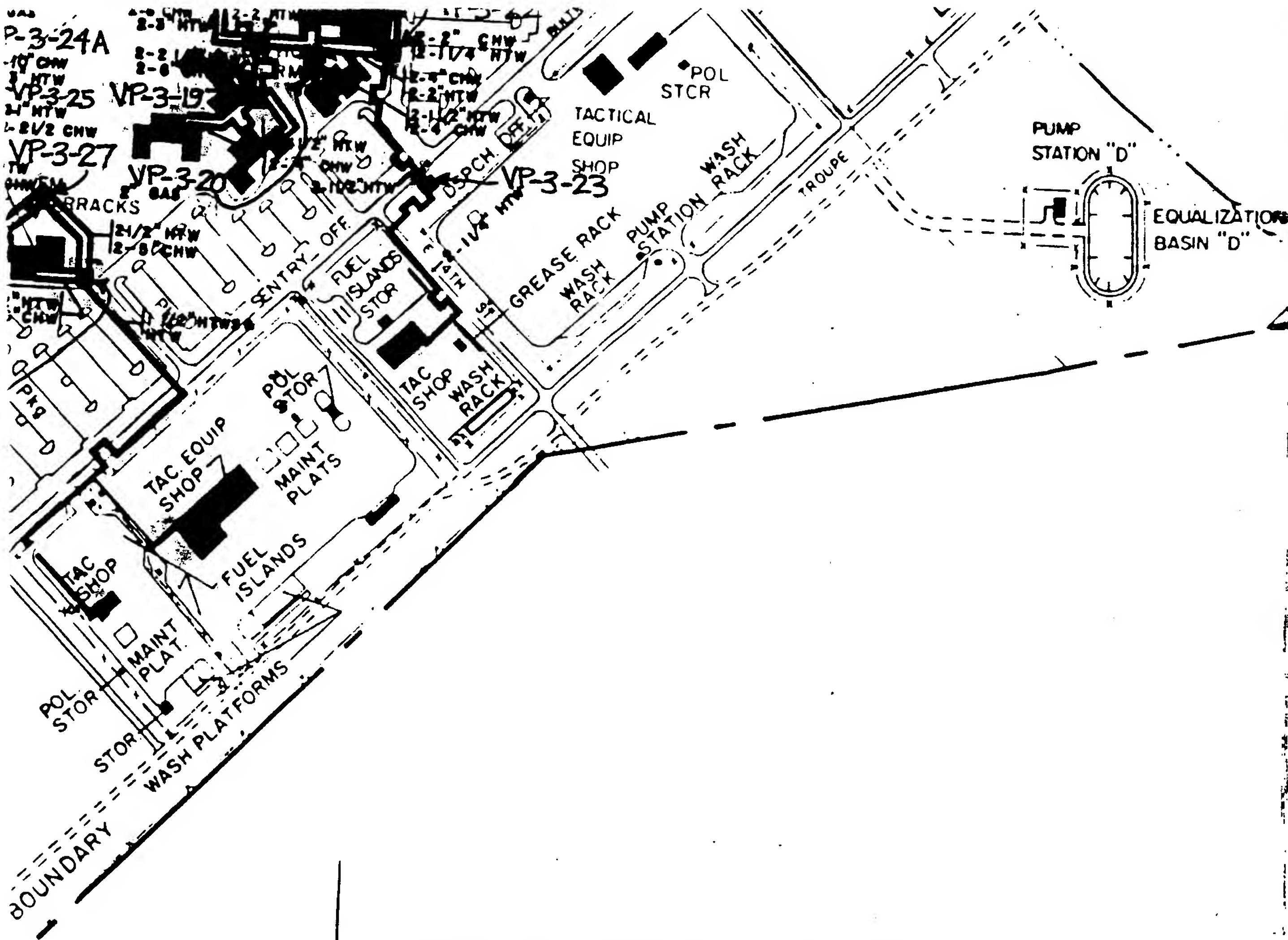

FORT STEWART HTW SYSTEM

SURVEY PLAN

PHASE I - CEP, SEP & MECH. RMS

PHASE II - VALVE & DRAIN PITS

PHASE III - DISTRIBUTION SYSTEMS
ZONE 1 DIST. SYSTEM
ZONE 2 DIST. SYSTEM
ZONE 3 DIST. SYSTEM
SEP DISTRIB. SYSTEM

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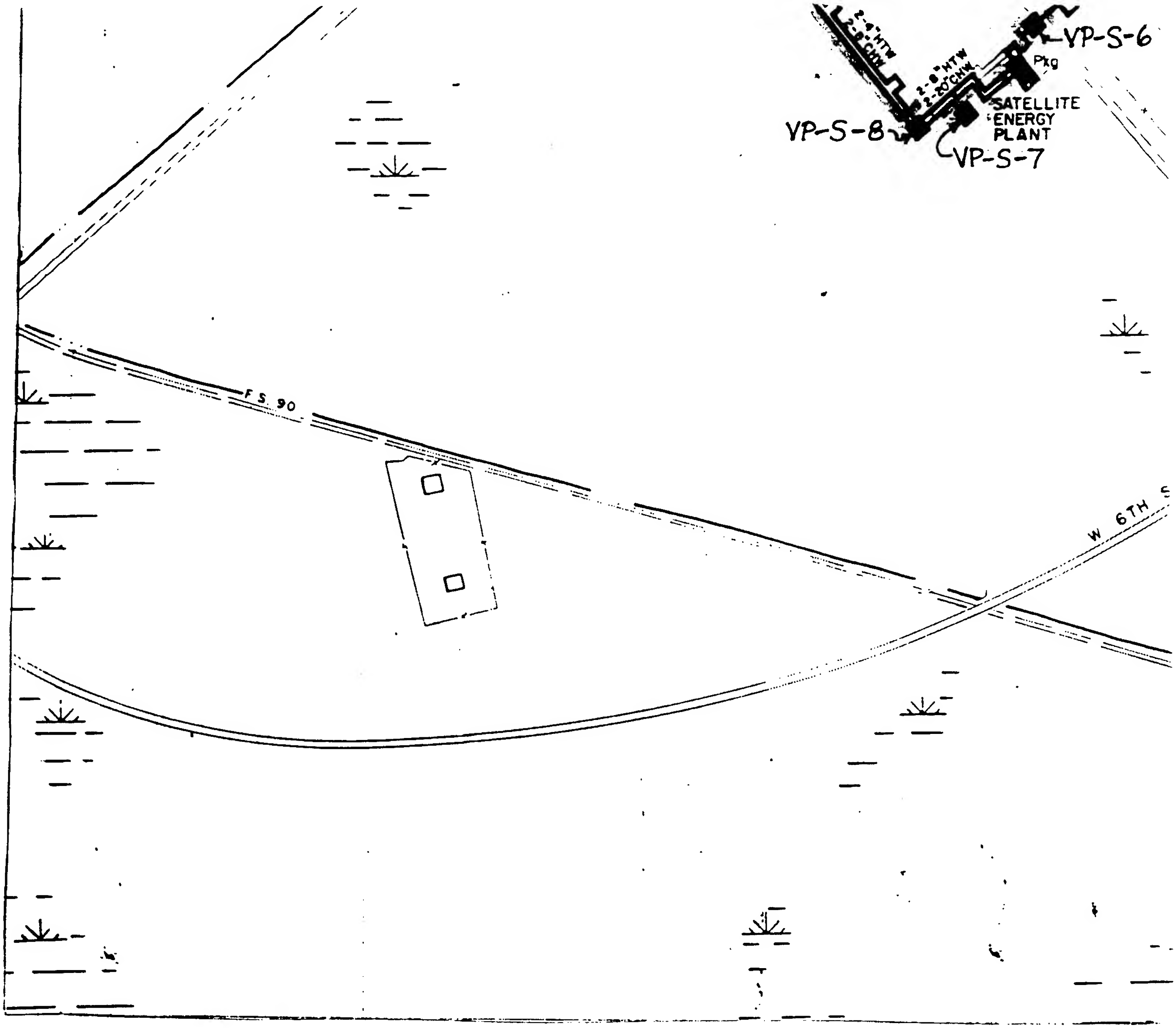
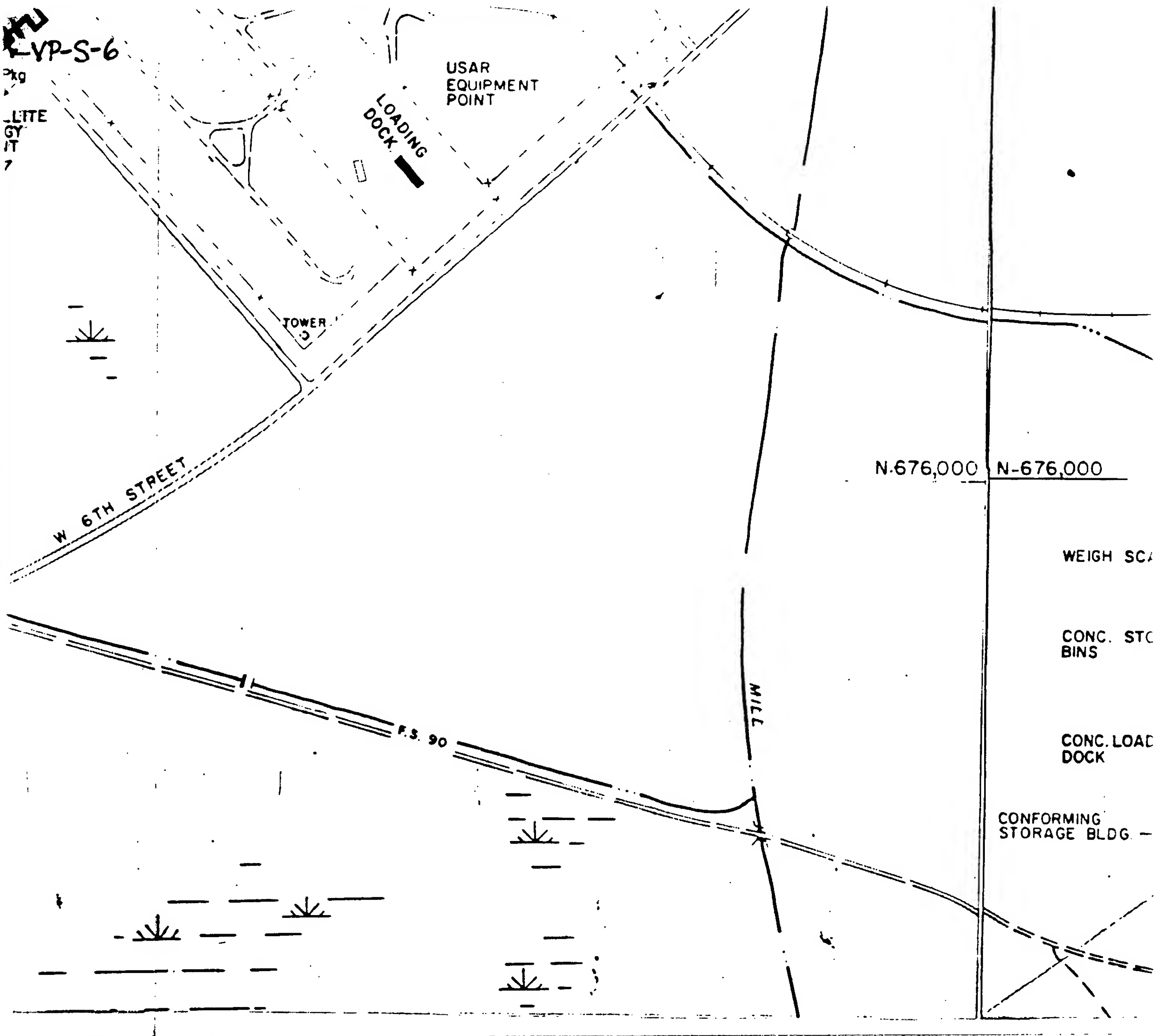
Architectural, Engineering, Planning and Environmental Services

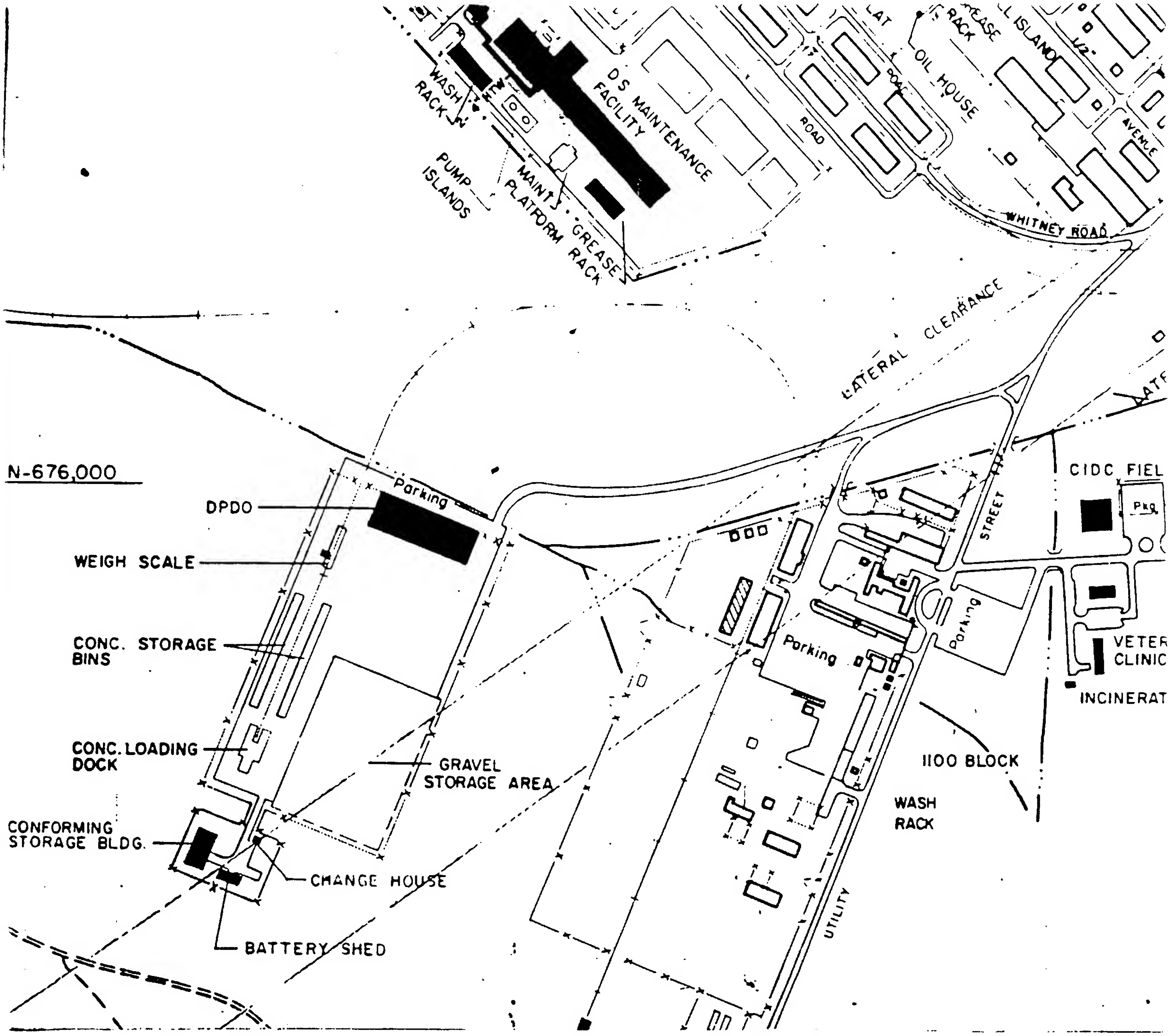


2-4" HTW
2-8" CHW
2-8" HTW
2-20" CHW
VP-S-6
Pkg
SATELLITE
ENERGY
PLANT
VP-S-8
VP-S-7
F S 90
W 6TH S

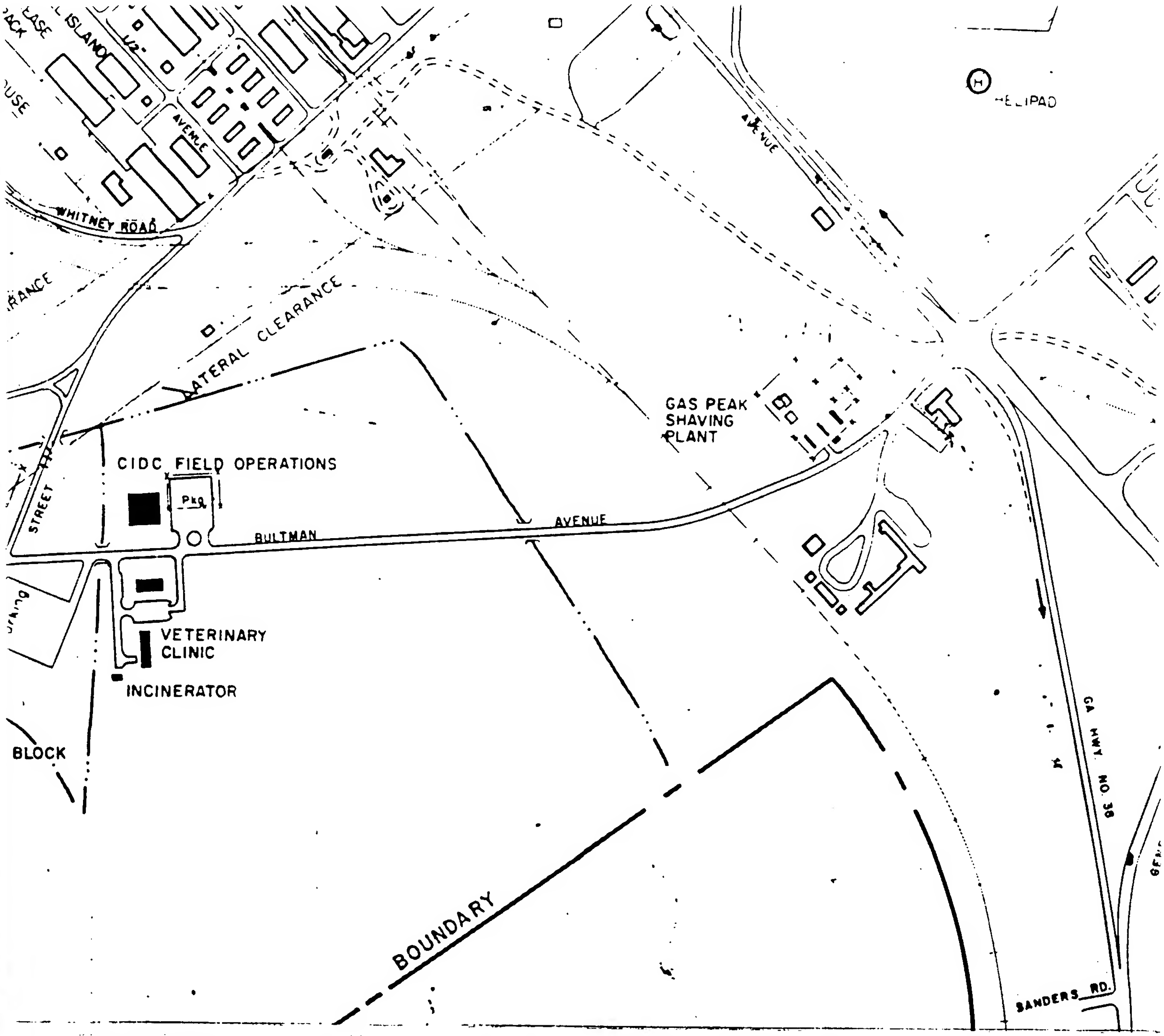


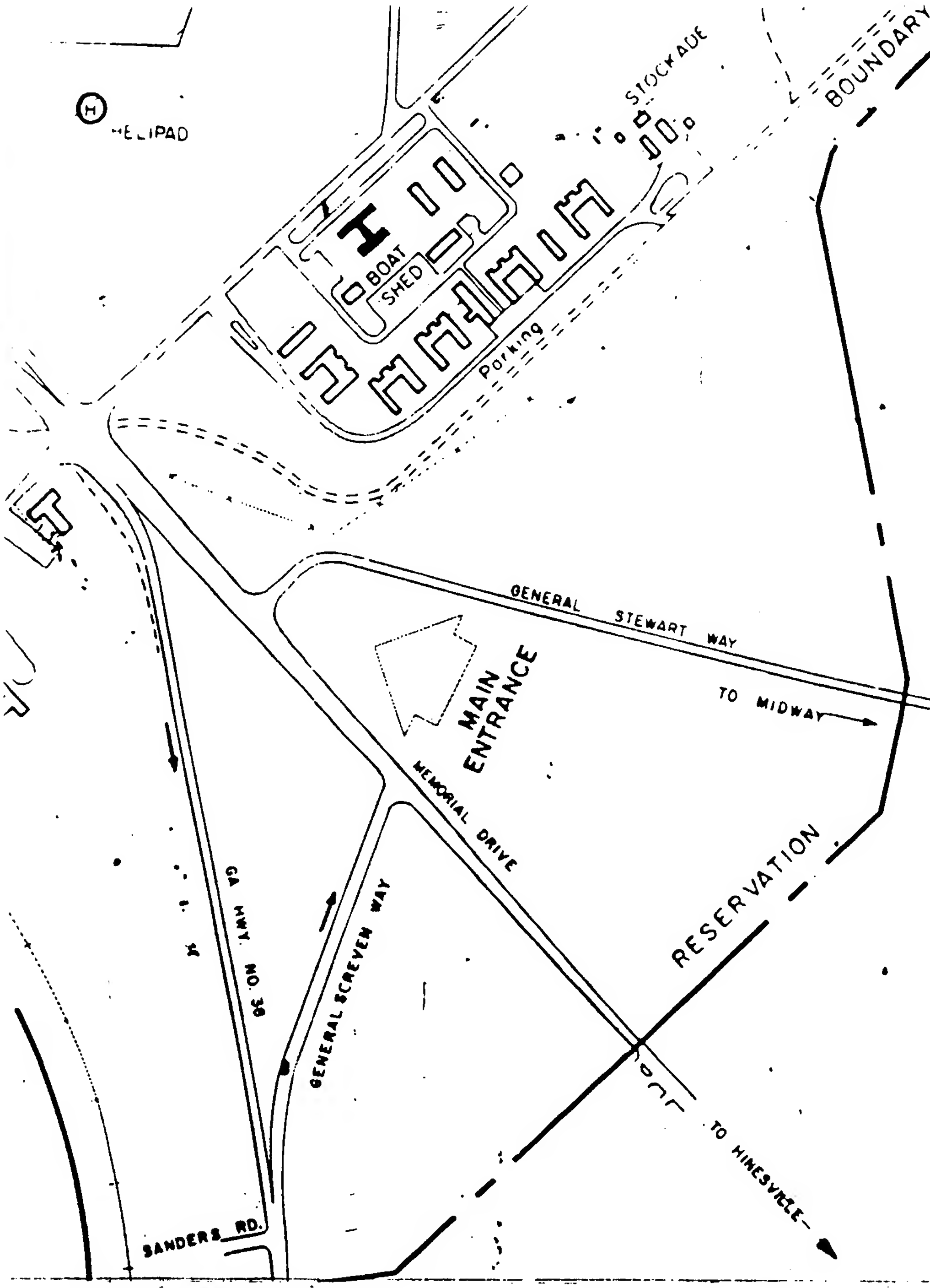
VP-S-6
Pkg
LITE
GY
IT
USAR
EQUIPMENT
POINT
LOADING
DOCK
TOWER
W 6TH STREET
N-676,000
N-676,000
WEIGH SC
CONC. STC
BINS
MILL
F.S. 90
CONC. LOAD
DOCK
CONFORMING
STORAGE BLDG

20



WASH RACK
PUMP ISLANDS
MAINT. PLATFORM
GREASE RACK
DS MAINTENANCE FACILITY
ROAD
OIL HOUSE
AVENUE
WHITNEY ROAD
LATERAL CLEARANCE
N-676,000
DPDO
Parking
WEIGH SCALE
CONC. STORAGE BINS
CONC. LOADING DOCK
GRAVEL STORAGE AREA
CONFORMING STORAGE BLDG.
CHANGE HOUSE
BATTERY SHED
Parking
Parking
STREET
CIDC FIEL
Pkg
VETER CLINIC
INCINERAT
1100 BLOCK
WASH RACK
UTILITY


HELIPAD
WHITNEY ROAD
AVENUE
LATERAL CLEARANCE
GAS PEAK
SHAVING
PLANT
CIDC FIELD OPERATIONS
Pkg
STREET
BULTMAN
AVENUE
VETERINARY
CLINIC
INCINERATOR
BLOCK
BOUNDARY
GA HWY. NO. 38
SANDERS RD.



FORT STE

SU

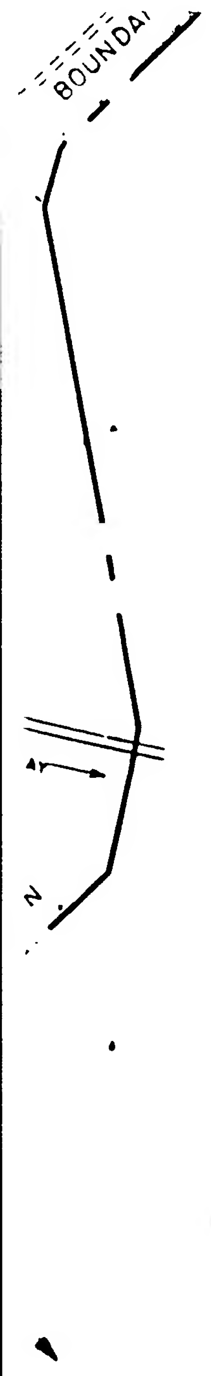
PHASE I -

PHASE II -

PHASE III -

Reynolds, Smith and
Architectural, Engine

23



FORT STEWART HTW SYSTEM

SURVEY PLAN

PHASE I - CEP, SEP & MECH. RMS ☐

PHASE II - VALVE & DRAIN PITS ☐

PHASE III - DISTRIBUTION SYSTEMS
- ZONE 1 DIST. SYSTEM ☐
- ZONE 2 DIST. SYSTEM ☐
- ZONE 3 DIST. SYSTEM ☐
- SEP DISTRIB. SYSTEM ☐

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A.3 ECO ENERGY AND COST CALCULATIONS

ECO NUMBER 1

REPLACEMENT OF THE EXISTING HTW DISTRIBUTION LINES WITH A NEW SHALLOW TRENCH DISTRIBUTION SYSTEM

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-1 REPLACE THE HTW DISTRIBUTION SYSTEM
FISCAL YEAR 1995 DISCRETE PORTION NAME: SHALLOW TRENCH HTW PIPING
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 21975320.		
B. SIOH	$ 1318519.		
C. DESIGN COST	$ 1318519.		
D. TOTAL COST (1A+1B+1C)	$ 24612360.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 24612360.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	7.	$ 89.	15.08	$ 1347.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	177890.	$ 238373.	14.88	$ 3546985.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		177897.	$ 238462.		$ 3548331.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 8857.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 131792.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 131792.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 247319.

5. SIMPLE PAYBACK PERIOD (1G/4) 99.52 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 3680124.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .15
(IF < 1 PROJECT DOES NOT QUALIFY)

ECO Number 1

Replacement of the existing HTW distribution lines with a new shallow trench distribution system.

Description

This project consists of replacing the existing underground HTW piping system with a new shallow trench distribution system. The existing HTW piping could be demolished and removed or it could be abandoned in place. The cost estimate and economic analysis assumes the existing HTW piping will be removed and sold for scrap. The new HTW piping design call for Schedule 80 steel pipe with welded joints. The new HTW pipe will be insulated with calcium silicate, installed inside a metal conduit and positioned in a shallow trench.

Analysis

This project is specifically called for by the scope of work, however, our surveys and analysis have indicated that the losses due to HTW leaks from the underground distribution system average only about 2.53 GPM which is 1,329,800 gallons per year. These losses are low considering the length and age of the piping system. However, there are substantial heating energy losses due to deteriorated and moist insulation.

Light steam flow and dripping was observed at many of the HTW conduit vent pipes during the valve pit survey. Since the estimated leaks in the HTW system were so low, it was assumed that the steam was being produced by ground water leaking into the HTW conduit. The conductivity of the insulation will increase dramatically with the introduction of moisture. A study of buried pipes for the district heating system at Fort McClellan estimated the heat transfer rates to be 55 Btu/Hr•LF for dry, insulated buried pipes and 275 Btu/Hr•LF for buried pipes with entrapped moisture and deteriorated insulation. The energy savings calculations assume that approximately one-half of the total length of HTW piping at Fort Stewart has deteriorated and moist insulation.

A small amount of energy and water savings are achieved by reducing the HTW losses from 2.53 GPM to approximately 0.10 GPM. The savings calculations and economic analysis assume an average of two leaks in the HTW piping each year and an average HTW loss of 20,000 gallons per leak.

The operation and maintenance savings associated with the need to repair about two HTW leaks per year is included in the economic analysis. The operation and maintenance cost includes trench excavation, HTW pipe repair and backfilling of the trench. Lengths and sizes of HTW piping used for energy savings calculations and cost estimates were taken from drawings titled Fort Stewart Central Heating and Cooling - Existing Conditions.

RS&H	SUBJECT: FORT STEWART	AEP NO: 694 1331 002	
	Replace HTW Piping	SHEET: 1	OF: 4
	DESIGNER: W. Todd	DATE: 2-7-96	
	CHECKER:	DATE:	

ECO-1 REPLACE HTW PIPING

Heat Loss from Buried Pipe

Assumptions:

1) Total length of supply and return pipe = 122 000 LF
2) About 1/2 of the piping has deteriorated insulation and entrapped moisture.
3) Average HTW pipe diameter is 6"
4) Average HTW supply temp. = 350 °F
5) Average HTW return temp. = 200 °F
6) HTW pipes have 4" of calcium silicate insulation
7) Heat loss from dry, insulated, buried pipes is about 55 Btu/HR·LF (see #9)
8) Heat loss from buried pipes with entrapped moisture and deteriorated insulation is 275 Btu/HR·LF (see #9)
9) Source is Ft. McClellan Study, see attached pages
10) Average ground temperature ≈ 70°F
11) Average boiler efficiency 68 percent

Current Heat Loss:

$$122\,000 \text{ LF} \times 0.5 \times 55 \ \text{Btu/HR·LF} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 3.355 \ \text{mBtu/HR}$$

$$122\,000 \text{ LF} \times 0.5 \times 275 \ \text{Btu/HR·LF} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 16.775 \ \text{mBtu/HR}$$

$$\text{Annual Heat Loss} = \left(3.355 \frac{\text{mBtu}}{\text{HR}} + 16.775 \frac{\text{mBtu}}{\text{HR}}\right) \times 8760 \frac{\text{HR}}{\text{YR}}$$

$$\text{Current annual heat loss} = 20.13 \frac{\text{mBtu}}{\text{HR}} \times 8760 \frac{\text{HR}}{\text{YR}} = 176340 \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Current Fuel use} = 176340 \frac{\text{mBtu}}{\text{YR}} \div 0.68 = \underline{259320 \frac{\text{mBtu}}{\text{YR}}}$$

RS&H

SUBJECT Fort Stewart
Replace HTW Piping
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET 2 OF 4
DATE 2-7-96
DATE

ECO-1 REPLACE HTW PIPING

Heat Loss w/ New Piping System

$$122\,000 \text{ LF} \times 55 \frac{\text{Btu}}{\text{HR} \cdot \text{LF}} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 6.71 \text{ mBtu/HR}$$

$$\text{Annual heat loss} = 6.71 \frac{\text{mBtu}}{\text{HR}} \times 8760 \frac{\text{HR}}{\text{YR}} = 58780 \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Current Fuel use} = 58780 \frac{\text{mBtu}}{\text{YR}} \div 0.68 = \underline{86{,}440 \frac{\text{mBtu}}{\text{YR}}}$$

RS&H	SUBJECT: Fort Stewart	AEP NO: 694 1331 002	
	Replace HTW Piping	SHEET: 3	OF: 4
	DESIGNER: W. Todd	DATE: 2-7-96	
	CHECKER:	DATE:	

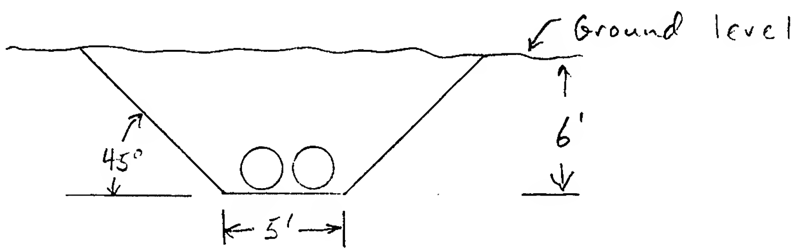
ECO-1 Replace HTW Piping W/o Leak Correlator

Assume 1/3 of the distance between valve pits must be dug up before the leak is found.

Average distance between valve pits:

$$\frac{9100 \text{ lf} + 4600 \text{ lf} + 6700 \text{ lf} + 17400 \text{ lf} + 8750 \text{ lf}}{95 \text{ Valve Pits}} = 490 \text{ LF/pit}$$

Area of excavation: Assume



$$6' \times 11' \times 490' \times \frac{1}{3} = 10780 \text{ cf} \div 27 \frac{\text{cf}}{\text{cy}} = 399 \Rightarrow 400 \text{ cy}$$

Excavation: \$ 4.41 /cy × 400 cy = \$1764/leak (96MM p 28)
Backfill: \$(1.53 + 2.13)/cy × 400 cy = \$1464/leak "
Repair: 3 men × 6 hrs × \$46.35/hr = 834/leak (96MM p 475)
Time Req'd: $400 \text{ cy} \times 0.080 \text{ hr/cy} \div 24 \frac{\text{hr}}{\text{day}} = 1.3 \frac{\text{days}}{\text{leak}}$ (96MM p 28)

O&M Costs = \$(1764 + 1464 + 834)/leak × 2 leaks/yr = $\boxed{\$8124/\text{year}}$

HTW Lost: (See graph of 1995 Make-up water use)

Average loss during leak = 25000 GPD
Average 1995 Make-up use = 10000 GPD

(25000 GPD − 10000 GPD) × 1.3 Day/leak = 20,000 Gal/leak

ECO-1 REPLACE HTW PIPING

Minor HTW leaks average 2.5 GPM (see table for calc)

$$2.53\ \text{GPM} \times 1440\ \frac{\text{min}}{\text{DAY}} \times 365\ \frac{\text{day}}{\text{yr}} = 1{,}329{,}800\ \text{GAL/yr}$$

Current HTW Losses :

$$1{,}329{,}800\ \text{GAL/YR} + 20{,}000\ \frac{\text{GAL}}{\text{LEAK}} \times 2\ \frac{\text{LEAKS}}{\text{YR}} = \underline{1{,}369{,}800\ \frac{\text{GAL}}{\text{YR}}}$$

Proposed HTW Losses :

Assume losses in new HTW system will average about 0.10 GPM over the life of the system.

$$0.10\ \text{GPM} \times 1440\ \frac{\text{min}}{\text{day}} \times 365\ \frac{\text{day}}{\text{YR}} = \underline{52{,}560\ \frac{\text{GAL}}{\text{YR}}}$$

ANNUAL SAVINGS

$$\text{Current} = 259320\ \frac{\text{mBtu}}{\text{YR}} + 5210\ \frac{\text{mBtu}}{\text{YR}} = 264{,}530\ \frac{\text{mBtu}}{\text{YR}}\ \text{(Heating)}$$

$$\text{New} = 86440\ \frac{\text{mBtu}}{\text{YR}} + 200\ \frac{\text{mBtu}}{\text{YR}} = 86640\ \text{mBtu/YR}\ \text{"}$$

$$\text{HEATING FUELS} = 264530 - 86640 = \boxed{177{,}890\ \text{mBtu/YR}}$$

$$\text{ELECTRICITY} = 6.8 - 0.3 = \boxed{6.5\ \text{mBtu/YR}}$$

$$\text{WATER} = \$762 - \$29 = \boxed{\$733/\text{YR}}$$

$$\text{O\&M} = \boxed{\$8124/\text{YR}}$$

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Existing HTW Piping	Date:	02/08/96
ECO Number:	1		

Assumptions:

1.	HTW temperature	380	°F
2.	Make-up water temperature	70	°F
3.	Boiler efficiency	68%	
4.	Pump head (from record drawings)	300	Ft H20
5.	Pump efficiency (from record drawings	72%	
6.	Motor efficiency	90%	
7.	Average heating fuel cost	\$1.34	/MBtu
8.	Electricity cost	\$0.0469	/kWh
9.	Water cost	\$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

1369800 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 3543.6 MBtu/Yr

Heating Fuel Use = 3543.6 MBtu/yr / 0.68 = 5211.2 MBtu/Yr

Heating Fuel Cost = 5211.2 MBtu/yr x \$1.34 /MBtu = \$6,983 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{2.61 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.27 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.27 BHP / 0.90 x 0.746 kW/HP = 0.23 kW

Electricity Use = 0.23 kW x 8760 Hr/Yr = 1991 kWh/Yr

Electricity Use = 1991 kWh/Yr x 0.003413 MBtu/kWh = 6.8 MBtu/Yr

Electricity Cost = 1991 kWh/Yr x \$0.0469 /kWh = \$93 /Year

Water Cost:

1369800 Gal/Yr x \$0.5562 /kGal = \$762 /Year

Total Utility Cost:

Heating Fuel Cost	\$6,983	/Year
Pumping (Elec) Cost	\$93	/Year
Water Cost	\$762	/Year
Total Utility Cost	\$7,838	/Year

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Install New Shallow Trench HTW Piping	Date:	02/08/96
ECO Number:	1		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

52560 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 136.0 MBtu/Yr

Heating Fuel Use = 136.0 MBtu/yr / 0.68 = 200.0 MBtu/Yr

Heating Fuel Cost = 200.0 MBtu/yr x $1.34 /MBtu = $268 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.10 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.01 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.01 BHP / 0.90 x 0.746 kW/HP = 0.01 kW

Electricity Use = 0.01 kW x 8760 Hr/Yr = 76 kWh/Yr

Electricity Use = 76 kWh/Yr x 0.003413 MBtu/kWh = 0.3 MBtu/Yr

Electricity Cost = 76 kWh/Yr x $0.0469 /kWh = $4 /Year

Water Cost:

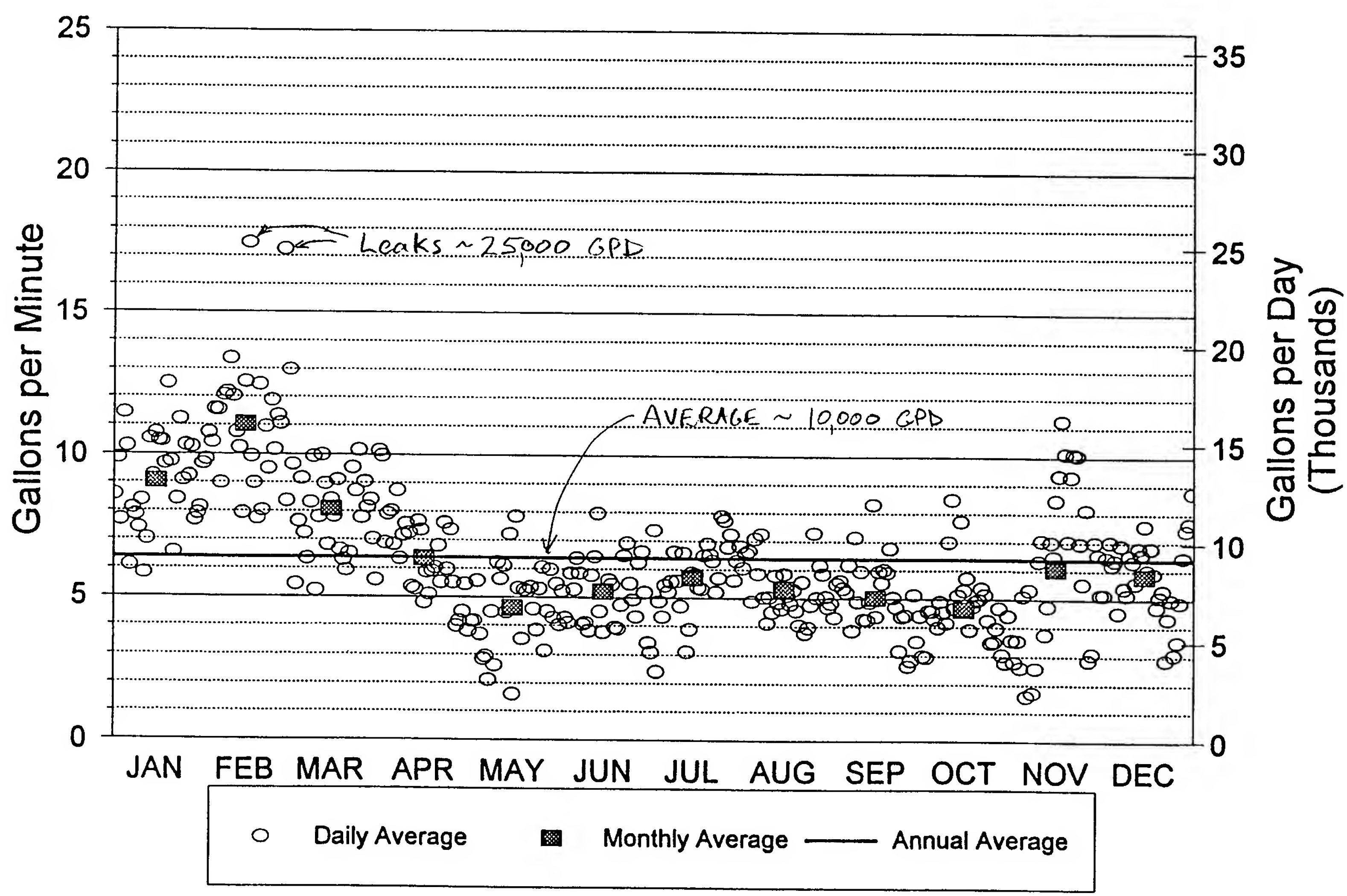
52560 Gal/Yr x $0.5562 /kGal = $29 /Year

Total Utility Cost:

Heating Fuel Cost	$268	/Year
Pumping (Elec) Cost	$4	/Year
Water Cost	$29	/Year
Total Utility Cost	$301	/Year

Figure #.#

Fort Stewart ~~CEP~~ HTHW Make-up Water, 1995



Fort Stewart – Central Energy Plant
Filename: FS-VPDIS.WQ1
12/15/95

Approximate Distance Between Valve Pits (1)

ZONE 1		ZONE 2N		ZONE 2S		ZONE 3		SEP ZONE		
PIT#	LN.FT.	PIT#	LN.FT.	PIT#	LN.FT.	PIT#	LN.FT.	PIT#	LN.FT.	
CP–B1	200	CP–V1	150	V1–B1	700	CP–?	700	C1–V1	1500	(2)
B1–V4	1000	V1–V2	200	B1–V1	1500	?–1	800	V1–V2	100	(2)
V1–V2	600	V2–V3	350	V1–B2	300	?–2	400	V2–V3	1700	(2)
V2–V3	200	V3–V4	650	B2–B3	550	2–2A	400	V3–V4	450	(2)
V3–V4	350	V4–V5	600	B3–V1	250	2A–3	500	V4–V5	600	(2)
V4–V5	300	V5–V6	800	V1–V2	250	3–3A	400	V5–V6	500	(2)
V5–V6	550	V6–V7	800	V1–V3	350	3A–6	550	V6–SP	100	(2)
V6–V7	400	V2–V8	750	V3–V4	250	4–5	900	SP–V7	200	
V7–V8	600	V8–V9	300	V3–V6	300	5–6	650	V7–V8	150	
V8–V9	350			V4–V5	200	6–7	850	V8–V9	550	
V9–V10	350			V3–V7	650	7–8	950	V9–V10	650	
V10–V11	250			V7–V8	250	8–9	1000	V10–V11	800	
V11–V12	500			V8–V9	500	9–10	1000	V11–V12	650	
V12–V13	1000			V9–V10	200	10–11	900	V12–V13	800	
V13–V14	350			V9–V11	450	11–12	500			
V14–V15	400					12–13	950			
V15–V16	400					13–13A	750			
V16–V17	500					12–14	950			
V17–V18	800					14–15	200			
						15–16	250			
						16–16A	300			
						16A–17	200			
						17–18	200			
						18–19	100			
						19–20	150			
						20–22	200			
						21–22	100			
						22–23	350			
						15–24C	350			
						24C–24B	200			
						24B–24	200			
						24–24A	200			
						24A–25	150			
						24A–25A	300			
						25A–26	100			
						26–26A	200			
						26A–27	250			
						27–28	250			

	ZONE 1	ZONE 2N	ZONE 2S	ZONE 3	SEP ZONE	
TOTAL LN.FT.	9100	4600	6700	17400	8750	
MILES	1.7	0.9	1.3	3.3	1.7	8.8
MAX LNFT/VP	1000	800	1500	1000	1700	
AVG LNFT/VP	479	511	447	458	625	
MIN LNFT/VP	200	150	200	100	100	
NO. OF PITS (1)	19	9	15	38	14	95

(1) There are other valve boxes and drain pits that are not shown on our HTW system map.

(2) These pipes carry steam.

CONF-8406132--2

ANALYSIS OF A SMALL DISTRICT STEAM SYSTEM AT FT. McCLELLAN, ALABAMA

CONF-8406132

DE84 014051

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For presentation at the
75th Annual Conference of the International
District Heating Association
Mount Washington, New Hampshire

June 17-20, 1984

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Of the total steam produced, we estimate that approximately 95% enters the steam distribution system. The remaining 5% is used within the boiler plants to power auxiliaries. This amounts to some 570 lb/hr on the average or 5.0 million lb/yr. Then approximately 96 million lb/yr enters the distribution system.

5. CAUSES FOR HEAT LOSS FROM BURIED PIPE

In order to minimize heat losses from steam and condensate pipe lines, the lines are usually insulated. Sometimes the pipes may run above ground but more commonly, the pipes are buried from two to six feet below the surface. If the insulation is intact and dry, the ground helps to insulate the pipe from cold temperatures in the winter and to reduce the heat losses. In this section, we present estimates of the heat losses for well insulated pipes as well as for pipes with deteriorated insulation and under various failure conditions.

Heat Loss From Dry, Insulated, Buried Pipes. Heat losses have been calculated for varied soil conditions and various types of insulation by King et. al. [3]. For the example of a six-inch steam line at 325°F with four inches of calcium silicate insulation in clay of average moisture and a soil temperature of 50°F, the rate of heat loss would be approximately 55 Btu/hour per linear foot of pipe. For the Ft. McClellan system with a steam temperature of 338°F and a ground temperature of 80°F, the loss rate would be about 52 Btu/hr-ft.

Heat Loss From Bare Pipes in Air. The simplest case to consider is a bare pipe exposed to ambient air on a dry, still day. For this case, the two major heat loss mechanisms are natural convection and radiation. We consider the case of a six-inch pipe with 338°F steam and ambient air at 150°F (a typical temperature inside a dry vault, where much of the bare pipe is found). The estimated loss due to natural convection under these conditions is about 350 Btu/hour per foot of pipe. Kreith [4] in Table 5.1 gives a value of emissivity of 0.8 for oxidized steel pipe. For the same pipe, the estimated radiation loss is approximately 570 Btu/hr-ft. The total loss per foot of bare pipe under these circumstances is then 920 Btu/hr-ft.

Buried Pipes With Entrapped Moisture and Deteriorated Insulation. Observations of actual buried steam lines indicates that the heat losses are substantially higher than the theoretical losses. Consideration of the magnitudes of the observed losses suggests that the pipe is behaving as though there were no insulation, and that the pipe is in direct contact with the surrounding soil. The most likely physical explanation is that the conductivity has been greatly enhanced by the deterioration of the insulation from the combined effects of heat and moisture that gets into the system by steam leaks or the intrusion of ground water. Entrapped moisture could be boiling near the surface of the pipe and condensing on the jacket, or subcooled boiling and the formation of a thermal convection loop in water filling the space between the pipe and jacket could be occurring. Both these processes produce extremely high heat transfer rates compared to the rate through dry insulation. If it is assumed that the conductivity of the insulation is infinite, the model of King et al. yields a heat transfer factor of about 1.8 Btu/hr-°F per foot of six-inch diameter pipe. For the six-inch pipe at 330°F and a 80°F ground temperature, the rate of heat loss per foot of pipe would be 460 Btu/hr-ft. This compares with the observed value of about 275 Btu/hr-ft.

Heat Loss From Flooding of Vaults. A commonly observed failure of steam lines is the failure of sump pumps in valve pits and the subsequent covering of the steam pipe with water. The source of the water can be either condensate from steam traps, which collects in the vault and causes flooding when sump pumps fail, or intrusion of ground water into the pits through cracks in the pit wall or around pipes that penetrate the pit walls. Water in the vaults is commonly heated to temperatures that are rather hot; we assume here that the water in the vault is heated to 150°F. The estimated rate of heat loss from a bare, six-inch steam pipe carrying 338°F steam and covered by 150°F water is 50,000 Btu/hr-ft. (This estimate could be higher, perhaps as high as 150,000 Btu/hr-ft depending on the assumed heat transfer mechanism.) Notice that the loss is nearly sixty times as large as the loss from dry, bare pipe. Perhaps even more interesting, the rate of heat loss would be 190 times greater than the

Fort Stewart - Measured/Estimated HTW Leaks
Filename: F-MAKEUP.WQ1

WATER LOSS ESTIMATE		
ITEM	GPD	GPM
1) Blowdown	1440	1.000
2) Sootblowing	468	0.325
3) CEP - Misc. Leaks	298	0.207
4) CEP - No. 4 Boiler	334	0.232
5) SEP Leaks	336	0.233
6) Valve Pit Leaks	1398	0.971
7) Mech. Equip. Room Leaks*	1260	0.875
Total Losses Identified	5534	3.843
Average 1995 Water Use	9179	6.374
- Total Losses Identified	5534	3.843
Estimated HTW Piping Leaks	3645	2.531

* Some of the leaks found during the survey of mechanical equipment rooms may have been found and repaired and other leaks might have developed since the surveys were performed.

PIE CHART VALUES

Blowdown/Soot Blowing	1908	1.325	20.8%
CEP/SEP/VP/ME Rm Leaks	3626	2.518	39.5%
HTW Piping Leaks	3645	2.531	39.7%

BAR CHART VALUES

	1993	1994	1995
Blowdown/Soot Blowing	1908	1908	1908
CEP/SEP/VP/ME Rm Leaks	3626	3626	3626
HTW Piping Leaks	7312	8922	3645

022 | Earthwork

		022 200 | Excav./Backfill/Compact.	Crew	Daily Output	Labor-Hours	Unit	1996 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P	
204	0500	Air tamp, add (A12.3 -110)	B-9	190	.211	C.Y.		4.25	.80	5.05	7.70	204
	0600	Vibrating plate, add	A-1	60	.133			2.64	1	3.64	5.30	
	0800	Compaction in 12" layers, hand tamp, add to above	1 Clab	34	.235			4.66		4.66	7.45	
	0900	Roller compaction operator walking, add	B-10A	150	.080			1.90	.57	2.47	3.58	
	1000	Air tamp, add	B-9	285	.140			2.84	.53	3.37	5.10	
	1100	Vibrating plate, add	A-1	90	.089			1.76	.67	2.43	3.55	
	1300	Dozer backfilling, bulk, up to 300' haul, no compaction	B-10B	1,200	.010			.24	.71	.95	1.15	
	1400	Air tamped	B-11B	240	.067			1.52	4.46	5.98	7.30	
	1600	Compacting backfill, 6" to 12" lifts, vibrating roller	B-10C	800	.015			.36	1.19	1.55	1.86	
	1700	Sheepsfoot roller	B-10D	750	.016			.38	1.29	1.67	2.01	
	1900	Dozer backfilling, trench, up to 300' haul, no compaction	B-10B	900	.013			.32	.95	1.27	1.53	
	2000	Air tamped	B-11B	235	.068			1.55	4.56	6.11	7.40	
	2200	Compacting backfill, 6" to 12" lifts, vibrating roller	B-10C	700	.017			.41	1.37	1.78	2.13	
	2300	Sheepsfoot roller	B-10D	650	.018			.44	1.49	1.93	2.32	
234	0010	**DRILLING AND BLASTING** Only, rock, open face, under 1500 C.Y.	B-47	225	.107	C.Y.	1.50	2.36	2.52	6.38	8.15	234
	0100	Over 1500 C.Y.	″	300	.080		1.50	1.77	1.89	5.16	6.50	
	2200	Trenches, up to 1500 C.Y.	B-47	22	1.091		4.50	24	25.50	54	71.50	
	2300	Over 1500 C.Y.	″	26	.923		4.29	20.50	22	46.79	60.50	
250	0010	**EXCAVATING, STRUCTURAL** Hand, pits to 6' deep, sandy soil	1 Clab	8	1	C.Y.		19.80		19.80	31.50	250
	0100	Heavy soil or clay		4	2			39.50		39.50	63	
	0300	Pits 6' to 12' deep, sandy soil		5	1.600			31.50		31.50	50.50	
	0500	Heavy soil or clay		3	2.667			53		53	84.50	
	0700	Pits 12' to 18' deep, sandy soil		4	2			39.50		39.50	63	
	0900	Heavy soil or clay		2	4			79		79	126	
	1500	For wet or muck hand excavation, add to above				%				50%	50%	
254	0010	**EXCAVATING, TRENCH** or continuous footing, common earth (A12.3 -110)										254
	0020	No sheeting or dewatering included										
	0050	1' to 4' deep, 3/8 C.Y. tractor loader/backhoe	B-11C	150	.107	C.Y.		2.43	1.39	3.82	5.30	
	0060	1/2 C.Y. tractor loader/backhoe	B-11M	200	.080			1.82	1.43	3.25	4.41	
	0090	4' to 6' deep, 1/2 C.Y. tractor loader/backhoe	″	200	.080			1.82	1.43	3.25	4.41	
	0100	5/8 C.Y. hydraulic backhoe	B-12Q	250	.064			1.56	1.58	3.14	4.12	
	0110	3/4 C.Y. hydraulic backhoe	B-12F	300	.053			1.30	1.50	2.80	3.64	
	0300	1/2 C.Y. hydraulic excavator, truck mounted	B-12J	200	.080			1.95	3.15	5.10	6.45	
	0500	6' to 10' deep, 3/4 C.Y. hydraulic backhoe	B-12F	225	.071			1.73	2	3.73	4.86	
	0600	1 C.Y. hydraulic excavator, truck mounted	B-12K	400	.040			.97	2.17	3.14	3.88	
	0900	10' to 14' deep, 3/4 C.Y. hydraulic backhoe	B-12F	200	.080			1.95	2.25	4.20	5.45	
	1000	1-1/2 C.Y. hydraulic backhoe	B-12B	540	.030			.72	1.32	2.04	2.56	
	1300	14' to 20' deep, 1 C.Y. hydraulic backhoe	B-12A	320	.050			1.22	1.72	2.94	3.77	
	1400	By hand with pick and shovel to 6' deep, light soil	1 Clab	8	1			19.80		19.80	31.50	
	1500	Heavy soil	″	4	2			39.50		39.50	63	
	1700	For tamping backfilled trenches, air tamp, add	A-1	100	.080			1.58	.60	2.18	3.19	
	1900	Vibrating plate, add		90	.089			1.76	.67	2.43	3.55	
	2100	Trim sides and bottom for concrete pours, common earth		600	.013	S.F.		.26	.10	.36	.53	
	2300	Hardpan		180	.044	″		.88	.33	1.21	1.77	
258	0010	**EXCAVATING, UTILITY TRENCH** Common earth										258
	0050	Trenching with chain trencher, 12 H.P., operator walking										
	0100	4" wide trench, 12" deep	B-53	800	.010	L.F.		.25	.11	.36	.50	
	0150	18" deep		750	.011			.26	.11	.37	.52	
	0200	24" deep		700	.011			.28	.12	.40	.56	
	0300	6" wide trench, 12" deep		650	.012			.30	.13	.43	.61	
	0350	18" deep		600	.013			.33	.14	.47	.66	
	0400	24" deep		550	.015			.36	.15	.51	.72	
	0450	36" deep		450	.018			.44	.19	.63	.88	
	0600	8" wide trench, 12" deep		475	.017			.42	.18	.60	.84	

A.3.1-15

CONSTRUCTION COST ESTIMATE

Project: Shallow Trench HTW Piping System
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 1

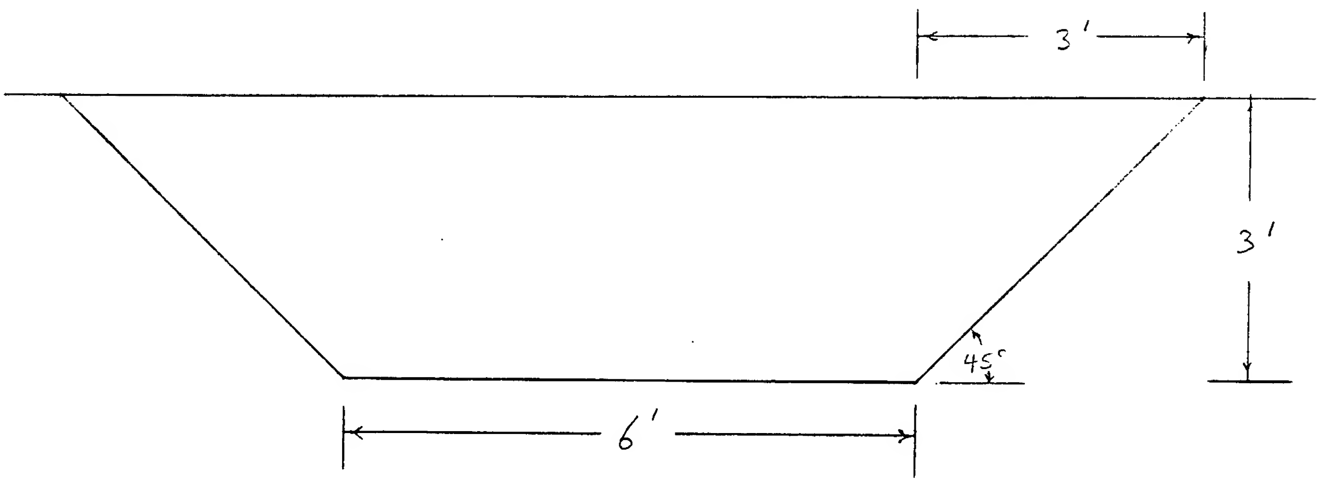
RS&H No.: 694-1331-002
Date: 14-Feb-96
Estimator: W.T.Todd
Filename: EST-1.WB2

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Excavating Trench	60900	CY	1.37	83433	1.73	105357	188,790	MMp23	MMp23
Piping Demolition, to 2"	40887	LF	NA	0	1.13	46202	46,202	MMp17	MMp17
Piping Demolition, to 4"	22880	LF	NA	0	1.51	34549	34,549	MMp17	MMp17
Piping Demolition, to 8"	34430	LF	NA	0	4.53	155968	155,968	MMp17	MMp17
Piping Demolition, to 16"	23540	LF	NA	0	7.55	177727	177,727	MMp17	MMp17
Scrap Salvage, Steel	1593	Ton	-60.00	-95570	NA	0	(95,570)	MMp17	MMp17
HTW Pipe, 2" Sch 80 Steel	40887	LF	5.17	211529	6.51	266031	477,560	MMp107	MMp107
Joint Weld, 2" Sch 80	4089	Ea	3.41	13942	27.00	110395	124,337	MMp109	MMp109
Insul., 2" Wall, 2" Pipe	40887	LF	3.37	137789	3.10	126750	264,539	MMp199	MMp199
HTW Pipe, 4" Sch 80 Steel	22880	LF	14.31	327413	11.61	265614	593,027	MMp107	MMp107
Joint Weld, 4" Sch 80	2288	Ea	4.65	10639	37.00	84656	95,295	MMp109	MMp109
Insul., 2" Wall, 4" Pipe	22880	LF	4.56	104333	3.37	77106	181,439	MMp199	MMp199
HTW Pipe, 6" Sch 80 Steel	24970	LF	30.95	772822	20.16	503395	1,276,217	MMp107	MMp107
Joint Weld, 6" Sch 80	2497	Ea	10.25	25594	81.50	203506	229,100	MMp109	MMp109
Insul., 2" Wall, 6" Pipe	24970	LF	5.85	146075	3.69	92139	238,214	MMp199	MMp199
HTW Pipe, 8" Sch 80 Steel	9460	LF	52.44	496082	24.48	231581	727,663	MMp107	MMp107
Joint Weld, 8" Sch 80	946	Ea	12.80	12109	102	96492	108,601	MMp109	MMp109
Insul., 2" Wall, 8" Pipe	9460	LF	6.95	65747	4.08	38597	104,344	MMp199	MMp199
HTW Pipe, 10" Sch 80 Stl	23540	LF	70.06	1649212	30.24	711850	2,361,062	MMp107	MMp107
Joint Weld, 10" Sch 80	2354	Ea	17.05	40136	136	320144	360,280	MMp109	MMp109
Insul., 2" Wall, 10" Pipe	23540	LF	8.65	203621	4.56	107342	310,963	MMp199	MMp199
Conduit, 20" Sch 40 Steel	33000	LF	75.05	2476650	62.04	2047320	4,523,970	MMp104	MMp104
Joint Weld, 20" Sch 40	3300	Ea	28.50	94050	226	745800	839,850	MMp109	MMp109
Conduit, 16" Sch 40 Steel	36410	LF	56.18	2045514	43.12	1569999	3,615,513	MMp104	MMp104
Joint Weld, 16" Sch 40	3641	Ea	23.50	85564	185	673585	759,149	MMp109	MMp109
Conduit, 14" Sch 40 Steel	20444	LF	48.06	982515	37.40	764587	1,747,102	MMp104	MMp104
Joint Weld, 14" Sch 40	2044	Ea	19.70	40274	157	320963	361,237	MMp109	MMp109
Valves, Fittings, etc.	All	--	10%	421704	10%	323560	745,264	Estimate	Estimate
Dozer Backfill, Trench	60900	CY	0.91	55419	0.30	18270	73,689	MMp23	MMp23
Compacting Backfill	60900	CY	1.31	79779	0.39	23751	103,530	MMp23	MMp23
Subtotal Bare Costs				10486375		10243236	$20,729,611		
Retrofit Cost Factors			4.0%	419455	7.0%	717027	1,136,482	MMp4	MMp4
Subtotal				10905830		10960263	21,866,093		
City Cost Index (Sav. GA)			-2.4%	-261740	-40.4%	-4427946	(4,689,686)	MEp439	MEp439
Subtotal				10644090		6532317	17,176,407		
OH & Profit Markups			10.0%	1064409	50.0%	3266159	4,330,568	MEp5	MEpIBC
Subtotal				11708499		9798476	21,506,975		
Sales Taxes			4.0%	468340		NA	468,340		
Total Construction Cost				12176839		9798476	21,975,315		
Design Fee				NA	6.0%	1318519	1,318,519		
SIOH				NA	6.0%	1318519	1,318,519		
Subtotal				12176839		12435514	24,612,353		
Contingency			0.0%	0	0.0%	0	0	MEp4	MEp4
Total Project Cost				12176839		12435514	$24,612,353		

LEGEND:
MMp### 1995 Means Mechanical Cost Data, page ###.

Shallow Trench Piping System

Excavation & Backfill :



Cubic yards (CY) per linear foot

$1' \times 3' \times 9' = 27\ ft^3$

$27\ ft^3 \div 27\ cf/cy = 1\ CY/_{LF}$

HTW pipe lengths and sizes were taken off of the Central Heating and Cooling drawings. A list of the pipe sizes and lengths used for cost estimating is contain on the following pages.

Fort Stewart
Estimate of HTW System Pipe Lengths
Filename: F-PIPING.WQ1

Pipe Service	Bldg. Served	Pipe Dia. (in)	Linear Ft w/loops	
HTWS	All (main)	10	3850	
HTWR	All (main)	10	3850	
HTWR	All (main)	10	5225	
STMS	All (main)	10	5390	
HTWS	All (main)	10	5225	
Subtotal			23540	LnFt
HTWR	All (main)	8	440	
HTWS	All (main)	8	440	
HTWS	All (main)	8	605	
HTWS	All (main)	8	1485	
HTWR	All (main)	8	605	
HTWR	All (main)	8	2200	
HTWS	All (main)	8	2200	
HTWR	All (main)	8	1485	
Subtotal			9460	LnFt
HTWR	All (main)	6	4070	
HTWS	All (main)	6	4070	
HTWS	All (main)	6	1980	
HTWR	All (main)	6	1980	
HTWS	All (main)	6	605	
HTWR	All (main)	6	605	
HTWR	All (main)	6	2035	
HTWS	All (main)	6	825	
HTWR	All (main)	6	825	
HTWS	All (main)	6	220	
HTWR	All (main)	6	220	
HTWS	All (main)	6	2035	
HTWS	All (main)	5	385	
HTWS	All (main)	5	990	
HTWR	All (main)	5	990	
HTWR	All (main)	5	385	
HTWR	All (main)	5	1375	
HTWS	All (main)	5	1375	
Subtotal			24970	LnFt
HTWR	All (main)	4	2860	
HTWS	All (main)	4	825	
HTWR	All (main)	4	825	
HTWS	All (main)	4	2860	
HTWS	All (main)	4	880	
HTWS	All (main)	4	550	
HTWR	All (main)	4	880	

Fort Stewart
Estimate of HTW System Pipe Lengths
Filename: F-PIPING.WQ1

Pipe Service	Bldg. Served	Pipe Dia. (in)	Linear Ft w/loops	
HTWS	All (main)	4	1650	
HTWR	All (main)	4	1100	
HTWR	All (main)	4	550	
HTWR	All (main)	4	1650	
HTWR	All (main)	4	5390	
HTWS	All (main)	4	1100	
HTWS	All (main)	3	880	
HTWR	All (main)	3	880	
Subtotal			22880	LnFt
HTWR	All (main)	2.5	1760	
HTWS	All (main)	2.5	1760	
HTWS	All (main)	2.5	440	
HTWR	All (main)	2.5	440	
HTWR	All (main)	2.5	550	
HTWS	All (main)	2.5	550	
HTWS	All (main)	2.25	990	
HTWR	All (main)	2.25	990	
HTWR	All (main)	2	990	
HTWS	All (main)	2	990	
HTWS	All (main)	2	770	
HTWR	All (main)	2	770	
HTWR	All (main)	2	5390	
HTWS	All (main)	2	770	
HTWR	All (main)	2	770	
HTWR	All (main)	2	4510	
HTWS	All (main)	2	4510	
HTWR	All (main)	2	880	
HTWS	All (main)	2	880	
HTWR	All (main)	2	880	
HTWS	All (main)	2	880	
HTWS	All (main)	1.5	330	
HTWR	All (main)	1.5	330	
HTWR	All (main)	1.25	1980	
HTWS	All (main)	1.25	1980	
Branch Piping (5% of mains)			1689	
Branch Piping (5% of mains)			1579	
Branch Piping (5% of mains)			1018	
Branch Piping (5% of mains)			1513	
Subtotal			40887	LnFt
Total			121737	LnFt

ECO NUMBER 2

REDUCE BLOWDOWN OF THE CASCADE HEATERS AND THE WOOD-FIRED BOILER

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-2 REDUCE BLOWDOWN FREQUENCY
FISCAL YEAR 1995 DISCRETE PORTION NAME: REDUCE BLOWDOWN BY 50%
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 500.		
B. SIOH	$ 0.		
C. DESIGN COST	$ 0.		
D. TOTAL COST (1A+1B+1C)	$ 500.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1000.	$ 1340.	14.88	$ 19939.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1000.	$ 1340.		$ 19939.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 2505.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 37274.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 37274.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 3845.

5. SIMPLE PAYBACK PERIOD (1G/4) .13 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 57214.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 114.43
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-2X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-2 REDUCE BLOWDOWN FREQUENCY
FISCAL YEAR 1995 DISCRETE PORTION NAME: REDUCE BLOWDOWN BY 50%
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 500.	
B. SIOH	$ 0.	
C. DESIGN COST	$ 0.	
D. TOTAL COST (1A+1B+1C)	$ 500.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	864.	$ 1158.	14.88	$ 17227.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		864.	$ 1158.		$ 17227.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 2505.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 37274.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 37274.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 3663.

5. SIMPLE PAYBACK PERIOD (1G/4) .14 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 54502.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 109.00
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-2Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-2 REDUCE BLOWDOWN FREQUENCY
FISCAL YEAR 1995 DISCRETE PORTION NAME: REDUCE BLOWDOWN BY 50%
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 500.		
B. SIOH	$ 0.		
C. DESIGN COST	$ 0.		
D. TOTAL COST (1A+1B+1C)	$ 500.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	765.	$ 1025.	14.88	$ 15253.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		765.	$ 1025.		$ 15253.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 2505.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 37274.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 37274.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 3530.

5. SIMPLE PAYBACK PERIOD (1G/4) .14 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 52528.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 105.06
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT: Fort Stewart
Reduce Blowdown
DESIGNER: G. Fallon
CHECKER:

AEP NO: 694 1331 002
SHEET: OF:
DATE: 2-7-96
DATE:

ECO No. 2 REDUCE BLOWDOWN FREQUENCY

BOILER WATER TESTS SHOW WATER IS CLEANER THAN IT SHOULD BE IMPLYING BLOWDOWN FREQUENCY IS TOO HIGH FOR SOLIDS BEING GENERATED.
INITIALLY, BLOWDOWN FREQUENCY SHOULD BE REDUCED, PERHAPS TO ODD NUMBERED DAYS AND THE DURATION OF BLOWDOWN SHOULD NOT BE CHANGED.

CURRENT HTW USE (see table for calculation)

$$1440 \frac{\text{GAL}}{\text{Day}} \times 365 \text{ days/yr} = \underline{525600 \text{ GAL/YR}}$$

ANNUAL COST for O&M

$$30 \text{ min/day} \times 365 \text{ day/YR} \times \$25.86/\text{hr} = \underline{\$4720/\text{YR}}$$

HTW SAVINGS

CURRENT BOILER WATER CONCENTRATIONS ARE ABOUT 1/2 THE RECOMMENDED VALUE, THEREFORE BLOWDOWN CAN BE CUT IN HALF.

$$525600 \text{ GAL/YR} \times 0.50 = \underline{262800 \text{ GAL/YR}}$$

O&M Cost Savings

$$\$4720/\text{YR} \times 0.5 = \boxed{\$2360/\text{YR}}$$

CAPITAL EXPENSE IS REQUIRED TO OBTAIN THIS SAVINGS.

Additional water analysis: 5 tests and reports × \$100 ea = $\underline{\$500}$

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Existing Blowdown	Date:	02/08/96
ECO Number:	2		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Average heating fuel cost	$1.34	/MBtu
5. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

525600 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1359.7 MBtu/Yr

Heating Fuel Use = 1359.7 MBtu/yr / 0.68 = 1999.6 MBtu/Yr

Heating Fuel Cost = 1999.6 MBtu/yr x $1.34 /MBtu = $2,679 /Year

Water Cost:

525600 Gal/Yr x $0.5562 /kGal = $292 /Year

Total Utility Cost:

Heating Fuel Cost	$2,679	/Year
Water Cost	$292	/Year
Total Utility Cost	$2,971	/Year

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Reduce Blowdown	Date:	02/08/96
ECO Number:	2		

Assumptions:

1. HTW temperature — 380 °F
2. Make-up water temperature — 70 °F
3. Boiler efficiency — 68%
4. Average heating fuel cost — $1.34 /MBtu
5. Water cost — $0.5562 /kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

262800 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 679.9 MBtu/Yr

Heating Fuel Use = 679.9 MBtu/yr / 0.68 = 999.8 MBtu/Yr

Heating Fuel Cost = 999.8 MBtu/yr x $1.34 /MBtu = $1,340 /Year

Water Cost:

262800 Gal/Yr x $0.5562 /kGal = $146 /Year

Total Utility Cost:

Heating Fuel Cost	$1,340	/Year
Water Cost	$146	/Year
Total Utility Cost	$1,486	/Year

ANNUAL SAVINGS

HEATING FUELS = 2000 - 1000 = $\boxed{\text{1000 MBtu/YR}}$

WATER COST = \$292 - \$146 = $\boxed{\text{\$146 /YR}}$

Estimated Water Consumption Due to Blowdown

Blowdown Point	Duration Est. (min)		Pipe Dia.	Pipe Length	Pres. Drop	Flow			Average
	Est. #1	Est. #2	(in)	(ft)	(ft)	(gpm)	(gpd, #1)	(gpd, #2)	(gpd)
Intermittent (1)									
Heater #1	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
Heater #2	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
Heater #3	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
No. 4 Boiler									
East Wall	0.33	0.50	1	100	400	87.5	29.2	43.8	
West Wall	0.33	0.50	1	100	400	87.5	29.2	43.8	
Rear Wall	0.33	0.50	1	100	400	87.5	29.2	43.8	
East Drum	0.33	0.50	1	100	400	87.5	29.2	43.8	
West Drum	0.33	0.50	1	100	400	87.5	29.2	43.8	
Sub-total Intermittent Blowdown - Summer							448	343	395
Heater #4	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
Heater #5	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
Additional Intermittent Blowdown - Winter							201	83	142
Continuous (2)									
Steam Drum	1440	0	1/16	100	400	1.353	1948	0	974
Total Blowdown - Summer							2396	343	1369
Total Blowdown - Winter							2597	425	1511

(1) Assumes 200 psi, 1 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.
(2) Assumes 200 psi, 1/16 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.

CONSTRUCTION COST ESTIMATE

Project: Reduce Blow Down
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 2

RS&H No.: 694-1331-002
Date: 05/24/96
Estimator: W.T.Todd
Filename: EST-2.WB2

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Boiler Water Analysis	5	Ea	0	0	100	500	500		Est.
Subtotal Bare Costs				0		500	$500		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				0		500	500		
City Cost Index (Sav. GA)			0%	0	0%	0	0	MMp533	MMp533
Subtotal				0		500	500		
OH & Profit Markups			0%	0	0%	0	0	MMp7	MMp475
Subtotal				0		500	500		
Sales Taxes			4.0%	0		NA	0	MMp476	
Total Construction Cost				0		500	500		
Design Fee				NA	0.0%	0	0		
SIOH				NA	0.0%	0	0		
Subtotal				0		500	500		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				0		500	$500		

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

BOILER SYSTEM WATER ANALYSIS PROGRAM

FORT STEWART BUILDING 1412 BOILER 4

Sample Number . . . . XCSTEWBW
Date Sampled 07/18/95
Date Received 08/14/95
Date Analyzed 08/17/95
Date Report Issued . 08/25/95

Boiler Water Analysis Report

Test Description	P&A	Plant	Control
Specific Sx Description			
Total Hardness, ppm $CaCO_3$	<2		
Filt Ortho Phos, ppm PO_4	23	35	30 - 60
Polymer, ppm			N/A
Sulfite, ppm Na_2SO_3	549	800	20 - 40
P Alkalinity, ppm $CaCO_3$	360		
Causticity, ppm OH^-	120	115	20 - 200
pH	11.8	11.8	
Neut Conductivity, mmhos	2000	2200	
Total Diss Solids, ppm	1400	1540	3000 - 3500

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............ Fort Stewart, GA 31314-5000
Phone................................ (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample................. BW From Boiler 4

Pretreatment.................................. Resin

Feedwater Temp (F)................................ 212
Feedwater Deoxygenation Method(s):
Mechanical.......................................
Oxygen Scavenger................... Sodium Sulfite

Boiler Type................................ Water Tube
Steam Gauge Pressure (PSIG)....................... 220
Boiler Horsepower.....................................
Boiler Output (PPH)........................... 99,000
Boiler Treatment:
pH Control...
Phosphate................sodium hexametaphosphate
Dispersant...

Condensate pH Control.......................morpholine

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement is good overall noting only a minor discrepancy for phosphate . Sulfite difference is normal since sulfite will degrade over time.

2. Results show that phosphate is below the control range. Sulfite is signficantly overdosed while causticity is within range. Blowdown is excessive based on low TDS.

continued...

BOILER SYSTEM WATER ANALYSIS PROGRAM

FORT STEWART BUILDING 1412 BOILER 4

Sample Number . . . . . RPSTEWBW
Date Sampled 06/06/95
Date Received 06/16/95
Date Analyzed 06/27/95
Date Report Issued . 07/06/95

Boiler Water Analysis Report

Test Description	P&A	Plant	Control
Specific Sx Description			
Total Hardness, ppm $CaCO_3$	<2		
Filt Ortho Phos, ppm PO_4	44	40	30 - 60
Tannin Color			
Polymer, ppm			N/A
Sulfite, ppm Na_2SO_3	650	780	20 - 40
P Alkalinity, ppm $CaCO_3$	410		
M Alkalinity, ppm $CaCO_3$			
Causticity, ppm OH^-	130	115	20 - 200
pH	11.7	11.7	
Neut Conductivity, mmhos	2480	2300	
Total Diss Solids, ppm	1750	1610	3000 - 3500

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............ Fort Stewart, GA 31314-5000
Phone................................ (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample................. BW From Boiler 4

Pretreatment........................ Sodium Cycle Softener

Feedwater Temp (F).................................. 212
Feedwater Deoxygenation Method(s):
Mechanical..
Oxygen Scavenger.................... Sodium Sulfite

Boiler Type................................ Water Tube
Steam Gauge Pressure (PSIG).......................... 220
Boiler Horsepower......................................
Boiler Output (PPH)............................ 98,000
Boiler Treatment:
pH Control..
Phosphate.................sodium hexametaphosphate
Dispersant..

Condensate pH Control........................morpholine

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Thank you for your comment on Form 276 regarding blowdown. We are glad to see that you are investigating the cause of low TDS and causticity which you believe is caused by something other than excessive blowdown because you have already reduced blowdown to a "bare minimum". Let us know what you find out and please see Recommendation #1 below for suggestions on how P&A can help via this sample program.

2. Test agreement is good.

3. Control of treatment levels is good except for sulfite which is much too high.

Continued...

Puckorius & Associates, Inc. P.O. Box 2440, Evergreen, CO 80439 303-674-9897

BOILER SYSTEM WATER ANALYSIS PROGRAM

FORT STEWART BUILDING 1412 BOILER 4

Sample Number	BCSTEWBW
Date Sampled	01/10/95
Date Received	01/17/95
Date Analyzed	01/24/95
Date Report Issued .	01/27/95

Boiler Water Analysis Report

Test Description	P&A	Plant	Control
Specific Sx Description	Sample not full.		
Total Hardness, ppm $CaCO_3$	<2		
Filt Ortho Phos, ppm PO_4	47	45	30 - 60
Tannin Color			
Polymer, ppm			N/A
Sulfite, ppm Na_2SO_3	690		20 - 40
P Alkalinity, ppm $CaCO_3$	460		
M Alkalinity, ppm $CaCO_3$			
Causticity, ppm OH^-	160	161	20 - 200
pH	12.0	11.2	
Neut Conductivity, mmhos	2580		
Total Diss Solids, ppm	1800	1540	3000 - 3500

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............ Fort Stewart, GA 31314-5000
Phone.................................. (912) 767-8931

Tester/Operator........................... Eddie Bryant
Building Sample is From........... Central Energy Plant
Description of Sample................. BW From Boiler 4

Pretreatment.................................... Resin

Feedwater Temp (F)................................ 212
Feedwater Deoxygenation Method(s):
Mechanical.......................................
Oxygen Scavenger.................... Sodium Sulfite

Boiler Type................................ Water Tube
Steam Gauge Pressure (PSIG)....................... 220
Boiler Horsepower.................................
Boiler Output (PPH)............................ 98,000
Boiler Treatment:
pH Control.......................................
Phosphate.................sodium hexametaphosphate
Dispersant.......................................

Condensate pH Control........................morpholine

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:
1. Excellent test agreement overall! There is some discrepancy on TDS however, our result is 260 ppm higher than the plant's c about 14%. Sulfite was not reported by the plant.
2. Results show good control of phosphate and caustic dosage. Sulfite is highly overdosed. Blowdown is excessive based on lo TDS.

RECOMMENDATIONS:
1. Reduce sulfite dosage significantly.
2. Calibrate conductivity meter to improve test agreement for conductivity/TDS.
3. Reduce blowdown to allow TDS to rise into range.

REPORT PREPARED BY: J. Tiangco

A.3.2-12

Puckorius & Associates, Inc. P.O. Box 2440, Evergreen, CO 80439 303-674-9897

ECO NUMBER 3

REDUCE SOOT BLOWING, INSTALL AN EXIT GAS TEMPERATURE INDICATOR ON THE WOOD-FIRED BOILER

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 REDUCE SOOT BLOWING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 208.
B. SIOH $ 13.
C. DESIGN COST $ 13.
D. TOTAL COST (1A+1B+1C) $ 234.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 234.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1226.	$ 1643.	14.88	$ 24445.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1226.	$ 1643.		$ 24445.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 47.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 699.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 699.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1690.

5. SIMPLE PAYBACK PERIOD (1G/4) .14 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 25145.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 107.46
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

STUDY: ECO-3X
LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 REDUCE SOOT BLOWING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 208.		
B. SIOH	$ 13.		
C. DESIGN COST	$ 13.		
D. TOTAL COST (1A+1B+1C)	$ 234.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 234.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1060.	$ 1420.	14.88	$ 21136.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1060.	$ 1420.		$ 21136.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 47.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 699.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 699.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 1467.

5. SIMPLE PAYBACK PERIOD (1G/4) .16 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 21835.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 93.31
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-3Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-3 REDUCE SOOT BLOWING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 208.		
B. SIOH	$ 13.		
C. DESIGN COST	$ 13.		
D. TOTAL COST (1A+1B+1C)	$ 234.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 234.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	937.	$ 1256.	14.88	$ 18683.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		937.	$ 1256.		$ 18683.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 47.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 699.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 699.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1303.

5. SIMPLE PAYBACK PERIOD (1G/4) .18 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 19382.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 82.83
(IF < 1 PROJECT DOES NOT QUALIFY)

SUBJECT	Fort Stewart	AEP NO	694 1331 002
	Reduce Soot Blowing	SHEET	OF
DESIGNER	G. Fallon	DATE	2-8-96
CHECKER		DATE	

ECO No. 3 DECREASE SOOT BLOWING FREQUENCY

BOILER SOOT BLOWERS ARE OPERATED ONCE PER SHIFT REGARDLESS OF THE BOILER TUBE CLEANLINESS.

DIAMOND POWER (SOOTBLOWER MFGR) CALCULATES 325 LBS OF STEAM ARE CONSUMMED WITH EACH OPERATION THERE 2 BLOWERS ON NO. 4 BOILER

CURRENT USE

$$\text{Energy} = 2\ \text{blowers} \times 325\ \frac{\text{lb Steam}}{\text{blow}} \times 2\ \frac{\text{blows}}{\text{Shift}} \times 3\ \frac{\text{shift}}{\text{day}} \times 365\ \frac{\text{day}}{\text{YR}} = 1423500\ \frac{\text{lb Steam}}{\text{YR}}$$

$$1423500\ \frac{\text{lb steam}}{\text{YR}} \times \left(1199.6-(60-32)\right)\frac{\text{Btu}}{\text{lb}} \times \frac{1\ \text{mBtu}}{10^6\ \text{Btu}} = 1667.8\ \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Fuel} = 1667.8\ \text{mBtu/YR} \div 0.68\ \text{boiler eff.} = \underline{2453\ \text{mBtu/YR}}$$

$$\text{Water} = 1423500\ \frac{\text{lb. steam}}{\text{YR}} \div 8.34\ \frac{\text{lb}}{\text{gal}} = \underline{170683\ \text{GAL/YR}} \qquad \$95$$

DATA SHOWS EXIT GAS TEMPERATURE REMAINS NEARLY CONSTANT. IT IS THEREFORE REASONABLE TO ASSUME THAT THE BOILER ISN'T SUFFICIENTLY FOULED TO CAUSE EGT TO RISE. ASSUME THEREFORE THAT THE FREQUENCY COULD BE CUT IN HALF.

ANNUAL SAVINGS WOULD BE ABOUT 50%

ANNUAL SAVINGS

$$\text{Fuels} = 2453\ \text{mBtu/YR} \times 0.50 = \boxed{1226\ \text{mBtu/YR}}$$

$$\text{Water} = 170683\ \text{GAL/YR} \times 0.50 = \underline{85341\ \text{GAL/YR}}$$

$$\text{Water}\ \$ = 85341\ \frac{\text{GAL}}{\text{YR}} \times \$0.5562/1000\ \text{GAL} = \boxed{\$47/\text{YR}}$$

CONSTRUCTION COST ESTIMATE

Project: Reduce Soot Blowing
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 3

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-3.WB2

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Thermometer well	1	Ea	29	29	18.5	19	48	MMp167	MMp167
Thermometer	1	Ea	133	133	7.55	8	141	MMp313	MMp313
Subtotal Bare Costs				162		27	$189		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				162		27	189		
City Cost Index (Sav. GA)			0%	0	-44%	-12	(12)	MMp533	MMp533
Subtotal				162		15	177		
OH & Profit Markups			10%	16	53%	8	24	MMp7	MMp475
Subtotal				178		23	201		
Sales Taxes			4.0%	7		NA	7	MMp476	
Total Construction Cost				185		23	208		
Design Fee				NA	6.0%	12	12		
SIOH				NA	6.0%	12	12		
Subtotal				185		47	232		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				185		47	$232		

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

ECO NUMBER 4

REPAIR HTW AND STEAM LEAKS IN THE CEP AND THE SEP

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-4 REPAIR LEAKS IN THE CEP AND THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 4057.		
B. SIOH	$ 244.		
C. DESIGN COST	$ 244.		
D. TOTAL COST (1A+1B+1C)	$ 4545.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 4545.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 21.	15.08	$ 311.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1091.	$ 1462.	14.88	$ 21754.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1093.	$ 1483.		$ 22064.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 160.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2381.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 2381.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1643.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.77 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 24445.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 5.38
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-4X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-4 REPAIR LEAKS IN THE CEP AND THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 4057.
B. SIOH $ 244.
C. DESIGN COST $ 244.
D. TOTAL COST (1A+1B+1C) $ 4545.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 4545.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 21.	15.08	$ 311.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	943.	$ 1264.	14.88	$ 18803.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		945.	$ 1284.		$ 19113.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 160.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2381.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 2381.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1444.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.15 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 21494.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.73
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-4Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-4 REPAIR LEAKS IN THE CEP AND THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 4057.		
B. SIOH	$ 244.		
C. DESIGN COST	$ 244.		
D. TOTAL COST (1A+1B+1C)	$ 4545.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 4545.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 21.	15.08	$ 311.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	834.	$ 1118.	14.88	$ 16629.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		836.	$ 1138.		$ 16940.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 160.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 2381.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 2381.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1298.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.50 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 19321.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.25
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H	SUBJECT FORT STEWART	AEP NO 694 1331 002	
	Repair CEP & SEP Leaks	SHEET 1	OF
	DESIGNER W. Todd	DATE 2-12-96	
	CHECKER	DATE	

ECO - 4 REPAIR HTW AND STEAM LEAKS IN THE CEP AND SEP

The quantities of HTW losses are listed below and the calculations can be found on the following pages:

Misc. CEP Leaks = 0.207 gpm = 298 GPD

These leaks are all from valves stems, fittings and pump glands. It is hard for the pump glands to handle the high system operating pressure so we assumed that only about 50% of these leaks could be repaired.

Boiler No. 4 Leaks = 0.232 gpm = 334 GPD

These leaks include 3 faulty steam traps and two blowdown valves. Assume new steam traps and valves will reduce these leaks by about 90%.

Misc. SEP Leaks = 0.233 gpm = 336 GPD

These leaks are mainly due to leaking blowdown valves on the cascade heaters. Assume replacing the blowdown valves and tightening the other valves will eliminate 100% of these leaks.

$$\text{Current HTW Losses} = (298 + 334 + 336)\ \text{GPD} \times 365\ \frac{\text{day}}{\text{YR}} = \underline{353320\ \frac{\text{Gal}}{\text{YR}}}$$

$$\text{Proposed HTW Losses} = (298 \times 0.5 + 334 \times 0.1)\ \text{GPD} \times 365\ \frac{\text{day}}{\text{YR}} = \underline{66580\ \frac{\text{Gal}}{\text{YR}}}$$

RS&H

SUBJECT FORT STEWART
REPAIR CEP & SEP LEAKS
DESIGNER W. TODD
CHECKER

AEP NO 694 1331 002
SHEET 2 OF
DATE 2-12-96
DATE

ECO-4 SUMMARY

ANNUAL SAVINGS

HEATING FUELS = 1344 - 253 = $\boxed{1091 \text{ MBtu/YR}}$

ELECTRICITY = 1.8 - 0.3 = $\boxed{1.5 \text{ MBtu/YR}}$

WATER = \$197 - \$27 = $\boxed{\$160\text{/YR}}$

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Existing Leaks in the CEP and SEP	Date:	02/12/96
ECO Number:	4		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

353320 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 914.0 MBtu/Yr

Heating Fuel Use = 914.0 MBtu/yr / 0.68 = 1344.1 MBtu/Yr

Heating Fuel Cost = 1344.1 MBtu/yr x $1.34 /MBtu = $1,801 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.071 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.071 BHP / 0.90 x 0.746 kW/HP = 0.059 kW

Electricity Use = 0.059 kW x 8760 Hr/Yr = 514 kWh/Yr

Electricity Use = 514 kWh/Yr x 0.003413 MBtu/kWh = 1.75 MBtu/Yr

Electricity Cost = 514 kWh/Yr x $0.0469 /kWh = $24 /Year

Water Cost:

353320 Gal/Yr x $0.5562 /kGal = $197 /Year

Total Utility Cost:

Heating Fuel Cost	$1,801	/Year
Pumping (Elec) Cost	$24	/Year
Water Cost	$197	/Year
Total Utility Cost	$2,022	/Year

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Repair Leaks in the CEP and SEP	Date:	02/12/96
ECO Number:	4		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

66580 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 172.2 MBtu/Yr

Heating Fuel Use = 172.2 MBtu/yr / 0.68 = 253.3 MBtu/Yr

Heating Fuel Cost = 253.3 MBtu/yr x $1.34 /MBtu = $339 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.13 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.013 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.013 BHP / 0.90 x 0.746 kW/HP = 0.011 kW

Electricity Use = 0.011 kW x 8760 Hr/Yr = 97 kWh/Yr

Electricity Use = 97 kWh/Yr x 0.003413 MBtu/kWh = 0.33 MBtu/Yr

Electricity Cost = 97 kWh/Yr x $0.0469 /kWh = $5 /Year

Water Cost:

66580 Gal/Yr x $0.5562 /kGal = $37 /Year

Total Utility Cost:

Heating Fuel Cost	$339	/Year
Pumping (Elec) Cost	$5	/Year
Water Cost	$37	/Year
Total Utility Cost	$381	/Year

RS&H

SUBJECT	FORT STEWART	AEP NO	694 1331 002
	CEP Misc. Leaks	SHEET	1 OF 2
DESIGNER	W. Todd	DATE	2-2-96
CHECKER		DATE	

CEP MISCELLANEOUS LEAKS

Valves & Fittings:

	Leak Rate Estimate	
Cascade Heater No. 1		
- Valve to top of sight glass leaking steam	2	drop/sec
- Valve on top left of heater leaking steam	2	"
Cascade Heater No. 2		
- Valve on bottom left of heater leaking steam	2	"
Cascade Heater No. 3		
- Valve on top of sight glass leaking steam	2	"
Deaerator Tank		
- Strainer next to control valve leaking steam and about 3 drops/second HTW.	5	"
- Valve above stairs leaking steam	2	"
- Vent to outside blowing steam (intermittant)	2	"
Total values & fittings leaks	17	drops/sec

$$17 \text{ drops/second} \times 2.5\times10^{-3} \frac{\text{gpm}}{\text{d/s}} = \underline{0.042 \text{ gal/min}}$$

HTW Zone Pumps:

- P-4 & P-5 ~ 1 drop / 4 seconds = 0.0006 GPM
- P-10 ~ steady 1/8" stream * = 0.109 GPM
- P-11 ~ Intermittant 1/8" stream* = 0.054 GPM

RS&H

SUBJECT	Fort Stewart CEP Misc. Leaks	AEP NO	694 1331 002
		SHEET	2 OF 2
DESIGNER	W. Todd	DATE	2-2-96
CHECKER		DATE	

Pumps (continued)

- P-23 & P-24 ~ 2 drops / 3 seconds = 0.0017 GPM

* A 1/8" stream was measured and timed and found to be ~ 1.75 cups/min ÷ 16 $\frac{\text{cups}}{\text{gal}}$ ≈ 0.109 GPM

Total leaks from HTW Pumps = <u>0.165 GPM</u>

Total Miscellaneous CEP Leaks:

Valves & Fittings	0.042 GPM
HTW Zone Pumps	0.165 GPM
Total =	0.207 GPM

Central Energy Plant (CEP) Leak Test #4 Boiler

On November 30, 1995 a leak test was conducted at CEP to determine the extent of the leaks associated with Boiler No.4. A significant amount of steam continually vents from the No.4 blowdown tank. To quantify this loss, a CEP leak test would be conducted with the No.4 boiler configured in as a "tight" a mode as possible, and then a second test would be conducted with No.4 in a "normal" (leaky) configuration. The difference in the test results would be the leaks due to No. 4's normal configuration.

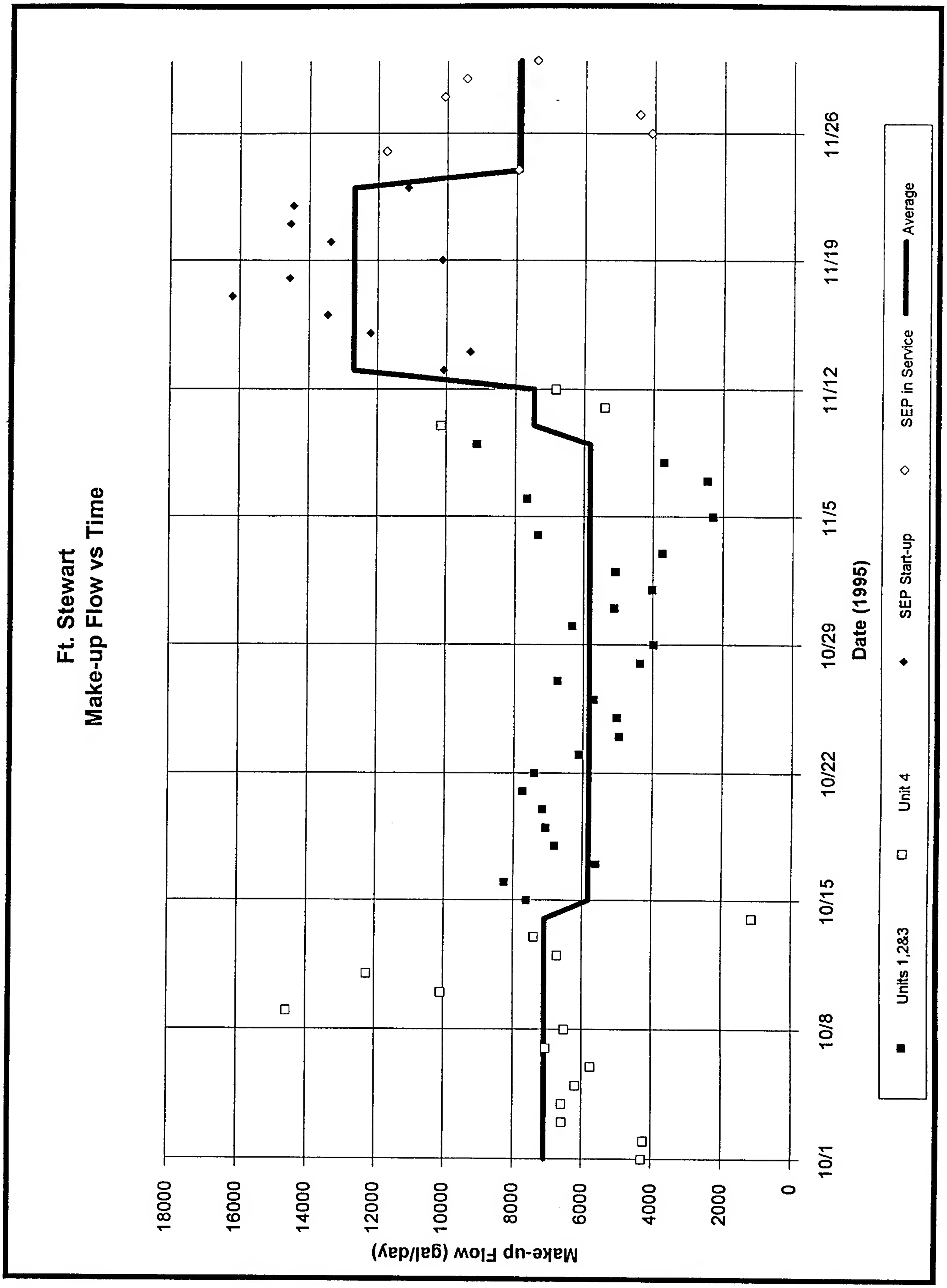
The leak test consists of measuring the make-up water required to maintain constant heater levels over an 8 hour period. Unfortunately, the test results showed no heater level changes over the 6 hour test period when a 6-7 inch change in the gauge glass level was expected. This testing technique has yielded results in the past. No explanation for the lack of results was determined; however, improper system valving is strongly suspected.

Configuring the boiler in as tight a configuration as possible stopped the blowdown tank steam venting. Leaking steam traps in the main steam line, the soot blower warm-up line, and in the boiler feed pump turbine line are the sources of the steam venting. Furthermore, the rear water wall header blowdown valves are leaking slightly. This leak was so small that only warm water entered the blow down tank.

A graph (enclosed) of the daily make-up consumption data shows a wide scattering of data, perhaps lending credence to the suspicion that observing heater tank levels over a short period of time (8 hours) yields uncertain results. However, when averaged over longer periods of time (weeks), yields more reliable results. The graph shows the daily make-up consumption (DMC) prior to October 15, 1995 averaged about 7000 gpd (4.86 gpm) while unit 4 alone was operating. During the period October 15 through November 10, 1995 unit 4 was shut down and units 1,2 and 3 were operating, and the DMC fell to 5900 gpd (4.10 gpm). This reduction in DMC can be attributed to two principal causes; 1) the general leaky state of unit No. 4; and 2) the required consumption of steam for sootblowing. The magnitude of the change 1100 gpd (0.764 gpm) seems reasonable. The fact that the consumption returned to the original levels when 4 boiler was returned to service implies that some of the leaks are in fact related to unit No. 4.

No. 4 Boiler Operation Recommendations

1. Repair steam trap leaks.
2. Reduce soot blowing frequency. Change from a time based operation to an exit gas temperature based operation.
3. Reduce blow down frequency to maintain American Boiler Manufacturers Association standard of 3500 ppm total dissolved solids.



Ft. Stewart
Make-up Flow vs Time
Make-up Flow (gal/day)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
10/1
10/8
10/15
10/22
10/29
11/5
11/12
11/19
11/26
Date (1995)
Units 1,2&3
Unit 4
SEP Start-up
SEP in Service
Average

Satellite Energy Plant (SEP) Leak test.

On November 29, 1995 the SEP was tested for system leaks. The testing procedure consists of stopping all steam flow to, and condensate return flow from, the SEP, and measuring the decrease in the level of the two cascade heaters in the SEP. By calculating the volume change in the heaters, a leak rate may be determined.

Time (EST)	9:46	10:34	11:13	11:37	11:48
Level (in)	14.3	14.3	14.3	14.3	14.3
Temp (°F)	375	360	340	335	330
Pres. (psig)	190	140	115	105	100

The data from the 2 hour test indicated that the water level in the heaters never changed while the circulating hot water showed a -45° temperature change and a -90 psig pressure change. It was concluded therefore the SEP system was "tight".

It is important to note however that the testing method used is quite crude over the short time period of the test. The two, 4000 gallon, cascade heaters are connected by symmetrical piping assuring "equal" water levels in both heaters. A one inch change in water level, at normal operating level, would be equivalent to 140 gallons of water. The leaks found and measured during the test are tabulated below.

Location	Amount (gpm)
East Heater gauge glass	2.23×10^{-4}
East Heater Steam Stop valve	2.11×10^{-3}
West Heater Equalization valve	1.00×10^{-3}
HTWS Check Valve	0.03
Both Heaters blow down valves	0.2
TOTAL	**0.233**

The total amount of water lost during the test is 0.233 gpm x 122 min. = 29 gals., or approximately 0.2 inches on the gauge glass. With normal, slow, level swings (generally attributable to sloshing) between the tanks, this leak rate is barley detectable in the sight glass over the time span of the test. Because of the large heater storage capacity, a longer test period is warranted. In the future this test could be a reasonable leak detection and quantification method at the SEP if conducted over longer testing periods. The best time for the test would be when the heat load from the SEP is minimal, perhaps on a warm day after a cool night.

CONSTRUCTION COST ESTIMATE

Project: Repair HTW Leaks in the CEP and SEP
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 4

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-4.WB2

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Travel time to bldgs.	0.5	hr		0	30.3	15	15		(1)
Repair/tighten valves	2.8	hr		0	30.3	83	83		(2)
Remove Steam Traps	3	Ea		0	34.5	104	104		MMp264
Steam Trap, 1", 600 lb	3	Ea	660	1980	34.5	104	2,084	MMp264	MMp264
Remove valves	4	Ea		0	52.8	211	211		MMp191
2" gate valve, 250 lb	4	Ea	256	1024	52.8	211	1,235	MMp191	MMp191
Subtotal Bare Costs				3004		728	$3,732		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				3004		728	3,732		
City Cost Index (Sav. GA)			0%	0	-44%	-322	(322)	MMp533	MMp533
Subtotal				3004		406	3,410		
OH & Profit Markups			10%	300	53%	215	515	MMp7	MMp475
Subtotal				3304		621	3,925		
Sales Taxes			4.0%	132		NA	132	MMp476	
Total Construction Cost				3436		621	4,057		
Design Fee				NA	6.0%	243	243		
SIOH				NA	6.0%	243	243		
Subtotal				3436		1107	4,543		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				3436		1107	$4,543		

LEGEND:
(1) Estimate 30 minutes for CEP to SEP round trip.
(2) Estimate 15 minutes per valve for 11 valves.
MMp### 1996 Means Mechanical Cost Data, page ###.

Installing Contractor's Overhead & Profit

Below are the average installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

Column A: Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

Column B: Workers' Compensation rates are the national average of state rates established for each trade.

Column C: Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

Columns D and E: Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

Column F: Column F lists the total of Columns B, C, D, and E.

Column G: Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

Column H: Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

Column I: Column I is Column H multiplied by eight hours.

		A		B	C	D	E	F	G	H	I
		Base Rate Incl. Fringes		Workers' Comp. Ins.	Average Fixed Overhead	Overhead	Profit	Total Overhead & Profit		Rate with O & P	
Abbr.	Trade	Hourly	Daily					%	Amount	Hourly	Daily
Skwk	Skilled Workers Average (35 trades)	$25.95	$207.60	20.2%	16.8%	13.0%	10%	60.0%	$15.55	$41.50	$332.00
	Helpers Average (5 trades)	19.25	154.00	21.4		11.0		59.2	11.40	30.65	245.20
	Foreman Average, Inside ($.50 over trade)	26.45	211.60	20.2		13.0		60.0	15.85	42.30	338.40
	Foreman Average, Outside ($2.00 over trade)	27.95	223.60	20.2		13.0		60.0	16.75	44.70	357.60
Clab	Common Building Laborers	19.80	158.40	21.9		11.0		59.7	11.80	31.60	252.80
Asbe	Asbestos Workers	28.55	228.40	19.7		16.0		62.5	17.85	46.40	371.20
Boil	Boilermakers	30.05	240.40	17.7		16.0		60.5	18.20	48.25	386.00
Bric	Bricklayers	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Brhe	Bricklayer Helpers	20.00	160.00	19.4		11.0		57.2	11.45	31.45	251.60
Carp	Carpenters	25.20	201.60	21.9		11.0		59.7	15.05	40.25	322.00
Cefi	Cement Finishers	24.35	194.80	12.8		11.0		50.6	12.30	36.65	293.20
Elec	Electricians	29.30	234.40	8.0		16.0		50.8	14.90	44.20	353.60
Elev	Elevator Constructors	30.05	240.40	9.6		16.0		52.4	15.75	45.80	366.40
Eqhv	Equipment Operators, Crane or Shovel	26.75	214.00	12.9		14.0		53.7	14.35	41.10	328.80
Eqmd	Equipment Operators, Medium Equipment	25.70	205.60	12.9		14.0		53.7	13.80	39.50	316.00
Eqlt	Equipment Operators, Light Equipment	24.70	197.60	12.9		14.0		53.7	13.25	37.95	303.60
Eqol	Equipment Operators, Oilers	21.90	175.20	12.9		14.0		53.7	11.75	33.65	269.20
Eqmm	Equipment Operators, Master Mechanics	27.55	220.40	12.9		14.0		53.7	14.80	42.35	338.80
Glaz	Glaziers	24.90	199.20	16.0		11.0		53.8	13.40	38.30	306.40
Lath	Lathers	24.95	199.60	13.5		11.0		51.3	12.80	37.75	302.00
Marb	Marble Setters	25.65	205.20	19.4		11.0		57.2	14.65	40.30	322.40
Mill	Millwrights	26.55	212.40	13.2		11.0		51.0	13.55	40.10	320.80
Mstz	Mosaic & Terrazzo Workers	25.25	202.00	11.0		11.0		48.8	12.30	37.55	300.40
Pord	Painters, Ordinary	22.95	183.60	16.8		11.0		54.6	12.55	35.50	284.00
Psst	Painters, Structural Steel	23.95	191.60	62.5		11.0		100.3	24.00	47.95	383.60
Pape	Paper Hangers	23.30	186.40	16.8		11.0		54.6	12.70	36.00	288.00
Pile	Pile Drivers	25.35	202.80	33.6		16.0		76.4	19.35	44.70	357.60
Plas	Plasterers	24.20	193.60	17.4		11.0		55.2	13.35	37.55	300.40
Plah	Plasterer Helpers	20.15	161.20	17.4		11.0		55.2	11.10	31.25	250.00
Plum	Plumbers	30.05	240.40	10.2		16.0		53.0	15.95	46.00	368.00
Rodm	Rodmen (Reinforcing)	27.75	222.00	36.3		14.0		77.1	21.40	49.15	393.20
Rofc	Roofers, Composition	22.55	180.40	37.4		11.0		75.2	16.95	39.50	316.00
Rots	Roofers, Tile & Slate	22.60	180.80	37.4		11.0		75.2	17.00	39.60	316.80
Rohe	Roofers, Helpers (Composition)	15.95	127.60	37.4		11.0		75.2	12.00	27.95	223.60
Shee	Sheet Metal Workers	28.95	231.60	13.8		16.0		56.6	16.40	45.35	362.80
Spri	Sprinkler Installers	31.30	250.40	10.4		16.0		53.2	16.65	47.95	383.60
Stpi	Steamfitters or Pipefitters	30.30	242.40	10.2		16.0		53.0	16.05	46.35	370.80
Ston	Stone Masons	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Sswk	Structural Steel Workers	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Tilf	Tile Layers	25.05	200.40	11.0		11.0		48.8	12.20	37.25	298.00
Tilh	Tile Layers Helpers	20.30	162.40	11.0		11.0		48.8	9.90	30.20	241.60
Trlt	Truck Drivers, Light	20.35	162.80	17.0		11.0		54.8	11.15	31.50	252.00
Trhv	Truck Drivers, Heavy	20.70	165.60	17.0		11.0		54.8	11.35	32.05	256.40
Sswl	Welders, Structural Steel	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Wrck	*Wrecking	19.80	158.40	44.8		11.0		82.6	16.35	36.15	289.20

*Not included in Averages.

City Cost Indexes

	DIVISION	FLORIDA																	
		MIAMI			ORLANDO			PANAMA CITY			PENSACOLA			ST. PETERSBURG			TALLAHASSEE		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.3	72.8	81.5	125.3	85.9	95.0	141.6	83.4	96.9	138.9	85.9	98.1	126.2	85.6	95.0	125.7	85.2	94.6
031	CONCRETE FORMWORK	94.2	71.0	74.5	97.3	71.6	75.5	95.8	37.8	46.6	84.5	69.7	72.0	94.1	64.8	69.3	97.3	53.0	59.7
032	CONCRETE REINFORCEMENT	95.1	72.5	82.4	95.1	79.0	86.0	99.3	64.5	79.7	101.5	64.9	81.0	98.5	74.3	84.9	95.1	65.2	78.3
033	CAST IN PLACE CONCRETE	91.5	75.4	84.6	88.7	78.0	84.1	95.2	43.0	72.9	95.2	69.0	84.0	101.4	70.2	88.1	91.7	58.4	77.5
3	CONCRETE	87.4	74.3	80.8	86.3	76.7	81.4	95.0	46.6	70.5	93.5	70.1	81.7	92.6	70.1	81.2	87.7	59.2	73.3
4	MASONRY	76.9	70.2	72.8	77.4	75.6	76.2	84.9	37.4	55.4	82.6	67.6	73.3	119.2	66.9	86.7	83.6	52.6	64.4
5	METALS	98.8	93.5	96.8	107.9	95.0	103.0	97.2	75.1	88.9	97.1	89.6	94.3	101.0	92.4	97.7	99.2	88.1	95.0
6	WOOD & PLASTICS	88.6	72.7	80.6	94.5	71.1	82.8	92.9	38.3	65.6	80.1	71.1	75.6	90.8	65.2	78.0	94.5	51.6	73.0
7	THERMAL & MOISTURE PROTECTION	99.6	74.6	88.0	96.6	75.6	86.9	96.9	38.3	69.9	96.6	66.9	82.9	96.3	63.1	81.0	96.6	58.8	79.1
8	DOORS & WINDOWS	95.9	69.5	89.5	98.1	68.2	90.9	95.7	35.2	81.2	95.7	66.5	88.7	96.8	60.4	88.0	98.1	53.9	87.4
092	LATH, PLASTER & GYPSUM BOARD	101.0	72.5	82.5	101.6	70.8	81.7	99.7	36.9	59.0	94.5	70.9	79.2	98.9	64.8	76.8	101.6	50.7	68.6
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	72.5	83.0	102.4	70.8	82.0	96.6	36.9	58.0	96.6	70.9	79.9	98.0	64.8	76.5	102.4	50.7	68.9
096	FLOORING & CARPET	121.8	75.3	110.7	113.0	74.9	103.8	112.3	24.6	91.3	106.7	68.0	97.4	111.4	67.8	100.9	113.0	49.7	97.8
099	PAINTING & WALL COVERINGS	100.9	70.1	83.0	104.2	77.6	88.7	104.2	34.5	63.7	104.2	78.5	89.3	104.2	65.4	81.6	104.2	55.7	76.0
9	FINISHES	108.6	71.4	89.7	107.7	72.7	89.9	107.2	34.4	70.2	104.5	70.5	87.2	106.0	65.3	85.3	107.7	51.9	79.3
10-14	TOTAL DIV. 10-14	100.0	81.8	96.1	100.0	83.9	96.6	100.0	65.4	92.6	100.0	73.3	94.3	100.0	76.8	95.1	100.0	74.0	94.5
15	MECHANICAL	100.0	72.9	88.0	100.0	70.8	87.1	100.0	34.6	71.1	100.0	68.8	86.2	100.0	68.7	86.2	100.0	54.8	80.0
16	ELECTRICAL	98.0	84.9	89.3	98.0	63.0	74.6	96.3	47.1	63.5	101.8	63.4	76.2	98.5	68.1	78.2	98.0	58.3	71.5
1-16	WEIGHTED AVERAGE	97.5	76.7	87.4	99.2	75.1	87.6	99.2	48.1	74.5	98.8	71.8	85.7	101.0	71.8	86.9	98.5	62.1	80.9

	DIVISION	FLORIDA			GEORGIA														
		TAMPA			ALBANY			ATLANTA			AUGUSTA			COLUMBUS			MACON		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	126.9	85.6	95.1	110.4	74.2	82.5	114.3	92.8	97.8	110.2	91.5	95.8	110.4	74.3	82.6	111.6	91.9	96.5
031	CONCRETE FORMWORK	97.3	64.9	69.8	96.9	50.8	57.8	98.0	70.3	74.5	94.5	61.8	66.7	96.9	50.4	57.4	95.9	65.9	70.5
032	CONCRETE REINFORCEMENT	95.1	74.3	83.4	95.1	76.4	84.6	98.5	77.5	86.7	104.0	69.1	84.4	95.1	76.4	84.6	97.4	76.7	85.8
033	CAST IN PLACE CONCRETE	101.7	70.2	88.2	95.5	48.9	75.6	101.1	71.2	88.3	95.6	57.9	79.5	95.5	49.5	75.8	95.5	53.3	77.5
3	CONCRETE	92.4	70.2	81.2	89.4	57.0	73.0	94.0	72.1	82.9	90.5	62.2	76.2	89.4	57.0	73.0	89.7	65.1	77.3
4	MASONRY	82.8	66.9	72.9	83.4	38.9	55.7	92.1	63.6	74.4	92.2	49.1	65.4	83.4	39.3	56.0	98.6	46.7	66.4
5	METALS	102.2	92.4	98.5	96.8	89.0	93.9	93.7	74.5	86.4	92.4	69.4	83.7	96.7	89.3	93.9	91.7	90.1	91.1
6	WOOD & PLASTICS	94.5	65.2	79.8	93.7	51.6	72.6	99.7	72.2	86.0	95.9	64.6	80.3	93.7	51.3	72.5	97.4	69.9	83.6
7	THERMAL & MOISTURE PROTECTION	96.6	64.3	81.7	96.4	55.7	77.6	94.2	70.0	83.0	93.6	59.5	77.9	96.1	55.7	77.5	95.1	62.9	80.2
8	DOORS & WINDOWS	98.1	60.4	89.0	95.9	53.7	85.7	94.2	67.9	87.9	90.6	59.3	83.1	95.9	53.8	85.7	94.2	64.8	87.1
092	LATH, PLASTER & GYPSUM BOARD	101.6	64.8	77.7	101.6	50.7	68.6	112.5	72.0	86.2	111.3	64.1	80.7	101.6	50.4	68.4	108.3	69.5	83.2
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	64.8	78.1	102.4	50.7	69.0	108.7	72.0	84.9	108.7	64.1	79.8	102.4	50.4	68.7	95.9	69.5	78.8
096	FLOORING & CARPET	113.0	67.8	102.1	113.0	40.4	95.6	87.8	75.0	84.8	86.7	51.5	78.2	113.0	41.0	95.7	87.8	47.5	78.2
099	PAINTING & WALL COVERINGS	104.2	65.4	81.6	100.9	50.4	71.5	99.0	72.1	83.4	99.0	47.9	69.3	100.9	48.3	70.3	102.4	59.0	77.2
9	FINISHES	107.7	65.3	86.1	105.8	48.1	76.4	95.1	71.5	83.1	94.4	58.6	76.1	105.7	47.8	76.2	91.5	62.0	76.5
10-14	TOTAL DIV. 10-14	100.0	76.8	95.1	100.0	69.5	93.5	100.0	75.4	94.8	100.0	71.0	93.8	100.0	69.4	93.5	100.0	73.6	94.4
15	MECHANICAL	100.0	68.7	86.2	100.0	56.8	80.9	100.1	71.7	87.5	100.1	54.0	79.7	100.0	46.2	76.2	100.0	52.1	78.8
16	ELECTRICAL	97.5	68.1	77.9	93.3	68.1	76.5	93.4	82.3	86.0	96.9	61.3	73.2	93.3	49.4	64.0	91.4	63.3	72.7
1-16	WEIGHTED AVERAGE	99.5	71.8	86.1	97.1	60.8	79.5	96.5	75.0	86.1	95.5	62.5	79.5	97.1	55.7	77.1	95.4	65.4	80.9

	DIVISION	GEORGIA						HAWAII			IDAHO								
		SAVANNAH			VALDOSTA			HONOLULU			BOISE			LEWISTON			POCATELLO		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.6	76.1	84.0	122.0	74.5	85.5	115.0	112.0	112.7	86.4	99.3	96.3	90.4	92.7	92.2	89.1	99.3	96.9
031	CONCRETE FORMWORK	97.0	60.5	66.0	80.8	51.9	56.3	102.1	158.7	150.1	97.4	89.3	90.5	106.3	87.1	90.0	97.4	89.3	90.5
032	CONCRETE REINFORCEMENT	100.7	69.5	83.2	100.8	50.3	72.5	109.9	125.0	118.4	96.0	78.4	86.1	108.6	96.1	101.6	96.3	78.5	86.3
033	CAST IN PLACE CONCRETE	91.5	56.6	76.6	93.0	57.4	77.8	170.2	127.7	152.0	98.6	93.8	96.6	107.8	93.9	101.8	99.6	93.8	97.1
3	CONCRETE	88.3	62.5	75.3	92.8	55.5	74.0	153.0	139.4	146.1	103.2	88.7	95.9	115.5	91.0	103.1	103.7	88.6	96.1
4	MASONRY	86.9	57.6	68.7	89.8	50.6	65.4	131.3	134.3	133.2	131.8	81.0	100.2	128.8	96.6	108.8	136.3	82.7	103.0
5	METALS	97.1	87.6	93.5	96.5	80.7	90.6	117.4	107.6	113.7	112.9	82.2	101.3	96.2	90.7	94.1	112.5	82.2	101.1
6	WOOD & PLASTICS	93.8	60.9	77.3	76.0	50.3	63.1	100.6	165.6	133.1	95.1	88.5	91.8	98.7	83.6	91.2	95.1	88.5	91.8
7	THERMAL & MOISTURE PROTECTION	96.4	59.2	79.3	96.1	60.0	79.5	109.5	133.7	120.6	97.9	84.0	91.5	167.6	89.8	131.7	98.0	83.8	91.5
8	DOORS & WINDOWS	95.9	56.7	86.4	91.4	46.3	80.5	110.6	146.5	119.2	94.9	81.7	91.7	116.3	85.0	108.7	94.9	78.5	91.0
092	LATH, PLASTER & GYPSUM BOARD	101.6	60.4	74.9	93.7	49.4	65.0	95.7	167.7	142.3	89.0	87.9	88.3	135.3	83.0	101.4	89.0	87.9	88.3
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	60.4	75.2	98.0	49.4	66.5	132.8	167.7	155.4	96.2	87.9	90.8	144.9	83.0	104.8	96.2	87.9	90.8
096	FLOORING & CARPET	113.0	60.7	100.4	105.1	48.5	91.5	127.8	128.3	127.9	97.5	74.8	92.1	135.1	97.9	126.2	97.5	74.8	92.1
099	PAINTING & WALL COVERINGS	100.9	59.9	77.0	100.9	43.7	67.6	123.8	148.0	137.9	109.4	67.9	85.2	134.4	91.3	109.3	109.4	78.2	91.3
9	FINISHES	105.8	60.5	82.8	101.9	50.0	75.5	124.5	153.9	139.5	93.2	84.6	88.8	156.4	89.0	122.1	93.2	85.8	89.4
10-14	TOTAL DIV. 10-14	100.0	71.7	94.0	100.0	70.1	93.7	100.0	129.2	106.2	100.0	86.1	97.0	100.0	100.6	100.1	100.0	86.1	97.0
15	MECHANICAL	100.0	55.8	80.5	100.0	48.7	77.3	100.1	119.4	108.6	99.8	85.6	93.5	100.6	94.1	97.7	99.8	85.6	93.5
16	ELECTRICAL	93.3	65.4	74.7	90.2	40.8	57.2	109.7	128.8	122.5	85.2	78.7	80.9	87.5	92.2	90.6	85.7	79.4	81.5
1-16	WEIGHTED AVERAGE	97.2	64.6	81.4	96.8	55.0	76.6	115.9	129.5	122.5	101.0	85.2	93.4	111.9	92.1	102.3	101.3	85.5	93.7

A.3.4-16

ECO NUMBER 5

REPAIR HTW LEAKS IN THE MECHANICAL EQUIPMENT ROOMS

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-5
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-5 REPAIR HTW LEAKS IN MECHANICAL ROOMS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 3804.		
B. SIOH	$ 229.		
C. DESIGN COST	$ 229.		
D. TOTAL COST (1A+1B+1C)	$ 4262.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 4262.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 29.	15.08	$ 435.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1612.	$ 2160.	14.88	$ 32142.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1614.	$ 2189.		$ 32577.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 235.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3497.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 3497.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 2424.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.76 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 36074.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 8.46
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO's 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-5X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-5 REPAIR HTW LEAKS IN MECHANICAL ROOMS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 3804.		
B. SIOH	$ 229.		
C. DESIGN COST	$ 229.		
D. TOTAL COST (1A+1B+1C)	$ 4262.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 4262.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 29.	15.08	$ 435.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1393.	$ 1867.	14.88	$ 27775.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1395.	$ 1895.		$ 28210.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 235.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3497.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 3497.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 2130.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 31707.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 7.44
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-5Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-5 REPAIR HTW LEAKS IN MECHANICAL ROOMS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 3804.		
B. SIOH	$ 229.		
C. DESIGN COST	$ 229.		
D. TOTAL COST (1A+1B+1C)	$ 4262.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 4262.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 29.	15.08	$ 435.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1232.	$ 1651.	14.88	$ 24565.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1234.	$ 1680.		$ 25000.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 235.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 3497.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 3497.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1915.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.23 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 28497.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 6.69
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT: FORT STEWART
REPAIR MECH. RM. LEAKS
DESIGNER: W. TODD
CHECKER:

AEP NO: 694 131 002
SHEET: OF:
DATE: 2-8-96
DATE:

ECO-5 SUMMARY

ANNUAL SAVINGS

HEATING FUELS = 1750 − 138 = $\boxed{1612 \text{ MBTU/YR}}$

ELECTRICITY = 2.3 − 0.2 = $\boxed{2.1 \text{ MBTU/YR}}$

WATER = \$256 − \$20 = $\boxed{\$236\text{/YR}}$

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Existing Leaks in Mech. Rooms	Date:	02/08/96
ECO Number:	5		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

459900 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1189.7 MBtu/Yr

Heating Fuel Use = 1189.7 MBtu/yr / 0.68 = 1749.6 MBtu/Yr

Heating Fuel Cost = 1749.6 MBtu/yr x $1.34 /MBtu = $2,344 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.88 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.09 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.09 BHP / 0.90 x 0.746 kW/HP = 0.08 kW

Electricity Use = 0.08 kW x 8760 Hr/Yr = 669 kWh/Yr

Electricity Use = 669 kWh/Yr x 0.003413 MBtu/kWh = 2.3 MBtu/Yr

Electricity Cost = 669 kWh/Yr x $0.0469 /kWh = $31 /Year

Water Cost:

459900 Gal/Yr x $0.5562 /kGal = $256 /Year

Total Utility Cost:

Heating Fuel Cost	$2,344	/Year
Pumping (Elec) Cost	$31	/Year
Water Cost	$256	/Year
Total Utility Cost	$2,631	/Year

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Repair Leaks in Mech. Rooms	Date:	02/08/96
ECO Number:	5		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

36260 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 93.8 MBtu/Yr

Heating Fuel Use = 93.8 MBtu/yr / 0.68 = 137.9 MBtu/Yr

Heating Fuel Cost = 137.9 MBtu/yr x $1.34 /MBtu = $185 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.07 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.01 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.01 BHP / 0.90 x 0.746 kW/HP = 0.01 kW

Electricity Use = 0.01 kW x 8760 Hr/Yr = 53 kWh/Yr

Electricity Use = 53 kWh/Yr x 0.003413 MBtu/kWh = 0.2 MBtu/Yr

Electricity Cost = 53 kWh/Yr x $0.0469 /kWh = $2 /Year

Water Cost:

36260 Gal/Yr x $0.5562 /kGal = $20 /Year

Total Utility Cost:

Heating Fuel Cost	$185	/Year
Pumping (Elec) Cost	$2	/Year
Water Cost	$20	/Year
Total Utility Cost	$207	/Year

RS&H	SUBJECT Fort Stewart	AEP NO 694 1331 002	
	Repair Leaks in ME Rooms	SHEET	OF
	DESIGNER W. Todd	DATE 2-6-96	
	CHECKER	DATE	

HTW Losses

The spreadsheet on the following pages lists the leaks found in all of the mechanical rooms. The leaks were measured with a beaker and timed with a stopwatch.

Major Leaks:

There are 8 major leaks totaling 0.737 GPM

$0.737 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{YR}} = 387{,}370 \text{ GAL/YR}$

Assume all of these leaks can be repaired.

Minor Leaks:

There are 38 minor leaks totaling 0.138 GPM

Assume 50% of the leaks can be repaired.

$0.138 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{Yr}} \times 0.5 = 36{,}270 \text{ GAL/YR}$

Current HTW losses $= 0.875 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{YR}} = \underline{459900 \frac{\text{GAL}}{\text{YR}}}$

Savings $= (387{,}370 + 36270) \text{ GAL/YR} = 423640 \frac{\text{GAL}}{\text{YR}}$

New HTW losses $= 459{,}900 \frac{\text{GAL}}{\text{YR}} - 423{,}640 \frac{\text{GAL}}{\text{YR}} = \underline{36260 \frac{\text{GAL}}{\text{YR}}}$

There are 36 leaking valves. Assuming 25% of them will have to be replaced:

36 valves x .25 => 9 valves to be replaced

Fort Stewart - HTW Distribution System Filename: FS-BLDGS.WB2

Building No.	HTW Zone	Building Type	DHW Temp.	Water Sample	Mech Rm Survey	HTW Leaks	Other Leaks	HTW Drop/Sec	HTW Cup/Min
206	3	Learning Center	80	DHW	Y	Y	Y	2.00	0.33
207	3	Dining Facility	124	DHW	Y	N	N		
208	3	Fitness Center	113	DHW	Y	Y	N	0.06	
211	3	Admin.	N/A	N/A	Y	Y	N	4.00	
212	3	Admin/Barracks	131	DHW	Y	N	N		
213	3	Barracks	120	DHW	Y	N	N		
215	3	Barracks	137	DHW	Y	Y	N	2.00	1.50
216	3	Barracks	110	DHW	Y	Y	N	2.50	
217	3	Admin.	N/A	N/A	Y	Y	N	0.13	-
218	3	Barracks	124	DHW	Y	N	Y		
223	3	Admin.	N/A	N/A	Y	Y	N	0.17	
224	3	Admin.	N/A	N/A	Y	Y	N	5.00	6.67
225	3	Admin.	N/A	N/A	Y	N	N		
230	3	Tac Equip Shop	N/A	N/A	Y	N	N		
241	3	Tac Equip Shop	N/A	N/A	Y	N	N		
260	3	Tac Equip Shop	N/A	N/A	Y	N	N		
270	3	Tac Equip Shop	N/A	N/A	Y	Y	N	2.20	
276	3	Tac Equip Shop	N/A	N/A	N				
302	3	Hospital	137	DHW	Y	N	N		
403	N/A	Child Care Ctr	N/A	N/A	Y	N/A	N		
439	N/A	Fitness Center	139	DHW	Y	N/A	N		
440	2	Dental Clinic	114	DHW	Y	N	N		
501	2	Barracks	134	DHW	Y	Y	N	0.33	
503	2	Barracks	122	DHW	Y	Y	N	2.00	0.25
504	2	Barracks	158	DHW	Y	Y	N		0.75
506	2	Admin.	N/A	N/A	Y	N	N		
507	2	Admin.	N/A	N/A	Y	Y	N	1.00	
508	2	Admin.	N/A	N/A	Y	N	N		
509	2	Admin.	N/A	N/A	Y	N	Y		
512	2	Dining Facility	145	DHW	Y	?	Y		1.17
514	2	Barracks	126	DHW	Y	Y	N	1.25	
515	2	Barracks	123	DHW	Y	N	Y		
516	2	Barracks	145	DHW	Y	?	Y		
517	2	Barracks	175	DHW	LOCKED				
518	2	Barracks	183	DHW	Y	?	Y	3.33	
520	2	Admin.	N/A	N/A	Y	N	Y		
521	2	Admin.	N/A	N/A	Y	Y	N	0.50	
522	2	Admin.	N/A	N/A	Y	Y	N	0.25	
523	2	Admin.	N/A	N/A	Y	N	N		
524	2	Admin.	N/A	N/A	Y	N	N		
525	2	Admin.	N/A	N/A	Y	Y	N	0.09	

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

Building No.	HTW Zone	Building Type	DHW Temp.	Water Sample	Mech Rm Survey	HTW Leaks	Other Leaks	HTW Drop/Sec	HTW Cup/Min
608	2	Fitness Center	127	DHW	Y	Y	N	0.08	
610	2	Chapel	115	DHW	Y	N	N		
612	2	Admin.	N/A	N/A	Y	Y	Y	0.08	
614	1	Admin.	N/A	N/A	Y	N	Y		
616	1	Admin.	N/A	N/A	Y	N	Y		
617	1	Admin.	N/A	N/A	Y	N	N		
618	1	Admin.	N/A	N/A	Y	N	N		
619	1	Admin.	N/A	N/A	Y	N	N		
620	1	Admin.	112	DHW	Y	N	N		
621	1	Admin.	91	DHW	Y	N	N		
622	1	Admin.	85	DHW	Y	N	N		
623	1	Admin.	109	DHW	Y	N	Y		
624	1	Admin.	109	DHW	Y	N	Y		
626	1	Dining Facility	145	DHW	Y	N	N		
628	1	Admin.	N/A	N/A	Y	Y	N	0.20	
629	1	Barracks	160	DHW	Y	?	Y		
630	1	Barracks	117	DHW	Y	N	Y		
631	1	Barracks	142	DHW	Y	Y	Y		0.88
632	1	Barracks	160	DHW	Y	N	Y		
633	1	Barracks	128	DHW	Y	Y	Y	2.00	
634	1	Barracks	LOCKED	LOCKED	Y	N	N		
635	1	Barracks	140	DHW	Y	Y	N	1.59	
636	1	Barracks	138	DHW	Y	Y	Y	1.22	
637	1	Barracks	158	DHW	Y	N	N		
638	1	Admin.	N/A	N/A	Y	N	Y		
639	1	Admin.	N/A	N/A	Y	Y	N	1.56	
640	1	Admin.	N/A	N/A	Y	N	N		
641	1	Admin.	N/A	N/A	Y	N	N		
642	1	Dining Facility	154	DHW	Y	N	Y		
643	1	Admin.	N/A	N/A	Y	Y	N	0.10	
644	1	Admin.	N/A	N/A	Y	Y	N	0.33	
645	1	Admin.	N/A	N/A	Y	N	N		
646	1	Admin.	N/A	N/A	Y	N	N		
647	1	Admin.	N/A	N/A	Y	Y	N	0.20	
648	1	Admin.	N/A	N/A	Y	N	Y		
649	1	Admin.	N/A	N/A	Y	N	N		

Fort Stewart - HTW Distribution System Filename: FS-BLDGS.WB2

Building No.	HTW Zone	Building Type	DHW Temp.	Water Sample	Mech Rm Survey	HTW Leaks	Other Leaks	HTW Drop/Sec	HTW Cup/Min
701	1	Health Clinic	152	DHW	Y	Y	N	1.00	
702	1	Ent. Center	143	DHW	Y	N	N		
703	1	Enl. Mens Club	N/A	N/A	LOCKED		Y		
704	1	Theater	N/A	N/A	Y	N	Y		
706	1	Branch Exchange	N/A	N/A	Y	N	Y		
708	1	Fitness Center	131	DHW	Y	N	Y		
710	1	Admin.	N/A	N/A	Y	N	Y		
712	1	Barracks	135	DHW	Y	N	Y		
713	1	Barracks	133	DHW	Y	N	Y		
714	1	Barracks	137	DHW	Y	N	Y		
715	1	Barracks	135	DHW	Y	Y	N	0.20	
717	1	Barracks	131	DHW	Y	N	N		
718	1	Barracks	124	DHW	Y	Y	Y	0.20	
719	1	Barracks	112	DHW	Y	Y	N	1.00	
720	1	Barracks	130	DHW	Y	N	Y		
721	1	Admin.	N/A	N/A	Y	N	N		
722	1	Admin.	N/A	N/A	Y	Y	Y	5.00	
723	1	Admin.	N/A	N/A	Y	N	N		
724	1	Admin.	N/A	N/A	Y	N	N		
725	1	Admin.	N/A	N/A	Y	N	N		
726	1	Dining Facility	158	DHW	Y	N	Y		
727	N/A	Training Facility	N/A	N/A	Y	N/A	N		
728	1	Admin.	N/A	N/A	Y	Y	N	3.05	
810	1	Barracks	131	DHW	Y	N	N		
811	1	Admin.	N/A	N/A	Y	N	N		
812	1	Admin.	N/A	N/A	Y	N	N		
813	1	Admin.	N/A	N/A	Y	N	N		
814	1	Admin.	N/A	N/A	Y	N	Y		
815	1	Admin.	N/A	N/A	Y	N	N		
816	1	Admin.	N/A	N/A	Y	N	Y		
818	1	Admin.	N/A	N/A	Y	N	N		
819	1	Admin.	N/A	N/A	Y	Y	N	0.13	

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

Building No.	HTW Zone	Building Type	DHW Temp.	Water Sample	Mech Rm Survey	HTW Leaks	Other Leaks	HTW Drop/Sec	HTW Cup/Min
1160	3	D.S. Maint Fac	N/A	N/A	Y	Y	N	2.03	
1170	3	G.S. Maint Fac	N/A	N/A	Y	N	N		
1208	1	Tac Equip Shop	N/A	N/A	Y	N	Y		
1209	1	Tac Equip Shop	N/A	N/A	Y	N	N		
1211	1	Tac Equip Shop	N/A	N/A	Y	N	N		
1245	N/A	Tac Equip Shop	N/A	N/A	Y	N/A	Y		
1259	1	Tac Equip Shop	N/A	N/A	Y	Y	N		0.25
1261	2	Tac Equip Shop	N/A	N/A	N				
1265	2	Tac Equip Shop	N/A	N/A	Y	N	N		
1280	N/A	Tac Equip Shop	N/A	N/A	Y	N/A	Y		
1320	2	Tac Equip Shop	N/A	N/A	Y	N	N		
1330	2	Tac Equip Shop	N/A	N/A	Y	Y	N	0.13	
1340	2	Tac Equip Shop	N/A	N/A	Y	N	N		
1412		C. Energy Plant	N/A	HTW	Y	Y			
1500	3	Div Logis Fac	N/A	N/A	w/ 1509?				
1503	3	Auto Hobby Shop	N/A	N/A	LOCKED				
1509	3	Div Logis Fac	N/A	N/A	Y	Y	Y	3.00	
1510	3	Tac Equip Shop	N/A	N/A	N				
1540	3	Tac Equip Shop	95	PW	N				
1720	2	D.S. Maint Fac	148	DHW	Y	N-N/A	N		
1810	2	Tac Equip Shop	N/A	N/A	N				
1820	2	Tac Equip Shop	N/A	N/A	Y	N-N/A	N		
1840	2	Tac Equip Shop	N/A	N/A	Y	N	Y		
2115	1	Dental Clinic	N/A	N/A	Y	N	N		
2125	1	Chapel	120	DHW	Y	N	N		
3001	S	S. Energy Plant	N/A	N/A	Y	Y			
3002	S	Admin.	N/A	N/A	Y	Y	N	5.20	
4502	S	Tac Equip Shop	N/A	N/A	N				
4528	S	Tac Equip Shop	N/A	N/A	N				
4577	S	Tac Equip Shop	N/A	N/A	N				
4578	S	Tac Equip Shop	N/A	N/A	N				
TOTALS		140			127	42	41	55.11 Drop/Sec	11.80 Cup/Min
						Leaks (GPM) =		0.138	0.737
						% of Total =		16%	84%
						Total Leaks =		0.875 GPM	

CONSTRUCTION COST ESTIMATE

Project:	Repair HTW Leaks in Mechanical Rooms	RS&H No.:	694-1331-002
Location:	Fort Stewart, GA	Date:	02/14/96
Basis:	Schematic Design	Estimator:	W.T.Todd
ECO No.:	5	Filename:	EST-5.WQ1

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Travel time to bldgs.	7.0	hr		0	30.3	212	212		(1)
Repair/tighten valves	4.5	hr		0	30.3	136	136		(2)
Repair/tighten flanges	2.3	hr		0	30.3	71	71		(3)
Remove valves (4)	9	Ea		0	52.8	475	475		MMp191
2" gate valve, 250 lb (4)	9	Ea	256	2304	52.8	475	2,779	MMp191	MMp191
Subtotal Bare Costs				2304		1369	$3,673		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				2304		1369	3,673		
City Cost Index (Sav. GA)			0%	0	-44%	-605	(605)	MMp533	MMp533
Subtotal				2304		764	3,068		
OH & Profit Markups			10%	230	53%	405	635	MMp7	MMp475
Subtotal				2534		1169	3,703		
Sales Taxes			4.0%	101		NA	101	MMp476	
Total Construction Cost				2635		1169	3,804		
Design Fee				NA	6.0%	228	228		
SIOH				NA	6.0%	228	228		
Subtotal				2635		1625	4,260		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				2635		1625	$4,260		

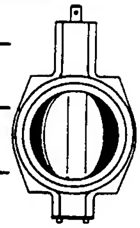
LEGEND:

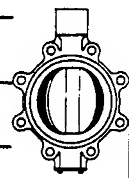
(1) Estimate 10 minutes per building for 42 buildings.
(2) Estimate 10 minutes per valve for 27 valves (also see note 4).
(3) Estimate 10 minutes per flange for 14 flanges.
(4) Assumes 25 % of the 36 leaking valves will be replaced.
MMp### 1996 Means Mechanical Cost Data, page ###.

151 950 | Valves

			CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
960	1050	3" size	Q-1	8	2	Ea.	175	54		229	276
	1060	4" size		5	3.200		215	86.50		301.50	370
	1070	5" size	Q-2	5	4.800		250	135		385	480
	1080	6" size		5	4.800		273	135		408	505
	1090	8" size		4.50	5.333		360	150		510	625
	1100	10" size		4	6		415	168		583	715
	1110	12" size		3	8		570	224		794	970
	1200	Lug type, lever actuator									
	1220	2" size	1 Plum	14	.571	Ea.	87	17.15		104.15	122
	1230	2-1/2" size	Q-1	9	1.778		89	48		137	172
	1240	3" size		8	2		95	54		149	188
	1250	4" size		5	3.200		121	86.50		207.50	265
	1260	5" size	Q-2	5	4.800		175	135		310	400
	1270	6" size		5	4.800		197	135		332	425
	1280	8" size		4.50	5.333		281	150		431	540
	1290	10" size		4	6		390	168		558	690
	1300	12" size		3	8		595	224		819	1,000
	1320	For gear actuator, add					60%				
	1400	Diverter, 150 lb. flanged, bronze or iron plugs									
	1440	2" pipe size	Q-1	2	8	Ea.	2,475	216		2,691	3,050
	1450	3" pipe size	"	1.50	10.667	"	3,550	289		3,839	4,350
	1650	Gate, 125 lb., N.R.S.,									
	2150	Flanged									
	2200	2" size	1 Plum	5	1.600	Ea.	252	48		300	350
	2240	2-1/2" size	Q-1	5	3.200		258	86.50		344.50	415
	2260	3" size		4.50	3.556		290	96		386	465
	2280	4" size		3	5.333		415	144		559	675
	2290	5" size	Q-2	3.40	7.059		705	198		903	1,075
	2300	6" size		3	8		705	224		929	1,125
	2320	8" size		2.50	9.600		1,225	269		1,494	1,750
	2340	10" size		2.20	10.909		2,150	305		2,455	2,850
	2360	12" size		1.70	14.118		2,950	395		3,345	3,850
	2370	14" size		1.30	18.462		3,575	520		4,095	4,725
	2380	16" size		1	24		5,225	675		5,900	6,775
	2420	For 250 lb., flanged, add					200%	10%			
	3550	OS&Y, flanged									
	3600	2" size	1 Plum	5	1.600	Ea.	128	48		176	215
	3640	2-1/2" size	Q-1	5	3.200		132	86.50		218.50	277
	3660	3" size		4.50	3.556		149	96		245	310
	3670	3-1/2" size		3	5.333		212	144		356	455
	3680	4" size		3	5.333		212	144		356	455
	3690	5" size	Q-2	3.40	7.059		350	198		548	690
	3700	6" size		3	8		350	224		574	730
	3720	8" size		2.50	9.600		625	269		894	1,100
	3740	10" size		2.20	10.909		1,150	305		1,455	1,750
	3760	12" size		1.70	14.118		1,525	395		1,920	2,275
	3770	14" size		1.30	18.462		2,950	520		3,470	4,050
	3780	16" size		1	24		4,575	675		5,250	6,050
	3790	18" size		.80	30		6,125	840		6,965	8,050
	3800	20" size		.60	40		8,550	1,125		9,675	11,100
	3830	24" size		.50	48		12,700	1,350		14,050	16,100
	3900	For 250 lb flanged, add					200%	10%			
	4350	Globe, OS&Y,									
	4540	Class 125, flanged									
	4550	2" size	1 Plum	5	1.600	Ea.	266	48		314	365
	4560	2-1/2" size	Q-1	5	3.200		281	86.50		367.50	440

R151 -090





MECHANICAL 15

A.3.5-14

Installing Contractor's Overhead & Profit

Below are the **average** installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

Column A: Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

Column B: Workers' Compensation rates are the national average of state rates established for each trade.

Column C: Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

Columns D and E: Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

Column F: Column F lists the total of Columns B, C, D, and E.

Column G: Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

Column H: Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

Column I: Column I is Column H multiplied by eight hours.

		A		B	C	D	E	F	G	H	I
		Base Rate Incl. Fringes		Work-ers' Comp. Ins.	Average Fixed Over-head	Over-head	Profit	Total Overhead & Profit		Rate with O & P	
Abbr.	Trade	Hourly	Daily					%	Amount	Hourly	Daily
Skwk	Skilled Workers Average (35 trades)	$25.95	$207.60	20.2%	16.8%	13.0%	10%	60.0%	$15.55	$41.50	$332.00
	Helpers Average (5 trades)	19.25	154.00	21.4		11.0		59.2	11.40	30.65	245.20
	Foreman Average, Inside ($.50 over trade)	26.45	211.60	20.2		13.0		60.0	15.85	42.30	338.40
	Foreman Average, Outside ($2.00 over trade)	27.95	223.60	20.2		13.0		60.0	16.75	44.70	357.60
Clab	Common Building Laborers	19.80	158.40	21.9		11.0		59.7	11.80	31.60	252.80
Asbe	Asbestos Workers	28.55	228.40	19.7		16.0		62.5	17.85	46.40	371.20
Boil	Boilermakers	30.05	240.40	17.7		16.0		60.5	18.20	48.25	386.00
Bric	Bricklayers	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Brhe	Bricklayer Helpers	20.00	160.00	19.4		11.0		57.2	11.45	31.45	251.60
Carp	Carpenters	25.20	201.60	21.9		11.0		59.7	15.05	40.25	322.00
Cefi	Cement Finishers	24.35	194.80	12.8		11.0		50.6	12.30	36.65	293.20
Elec	Electricians	29.30	234.40	8.0		16.0		50.8	14.90	44.20	353.60
Elev	Elevator Constructors	30.05	240.40	9.6		16.0		52.4	15.75	45.80	366.40
Eqhv	Equipment Operators, Crane or Shovel	26.75	214.00	12.9		14.0		53.7	14.35	41.10	328.80
Eqmd	Equipment Operators, Medium Equipment	25.70	205.60	12.9		14.0		53.7	13.80	39.50	316.00
Eqlt	Equipment Operators, Light Equipment	24.70	197.60	12.9		14.0		53.7	13.25	37.95	303.60
Eqol	Equipment Operators, Oilers	21.90	175.20	12.9		14.0		53.7	11.75	33.65	269.20
Eqmm	Equipment Operators, Master Mechanics	27.55	220.40	12.9		14.0		53.7	14.80	42.35	338.80
Glaz	Glaziers	24.90	199.20	16.0		11.0		53.8	13.40	38.30	306.40
Lath	Lathers	24.95	199.60	13.5		11.0		51.3	12.80	37.75	302.00
Marb	Marble Setters	25.65	205.20	19.4		11.0		57.2	14.65	40.30	322.40
Mill	Millwrights	26.55	212.40	13.2		11.0		51.0	13.55	40.10	320.80
Mstz	Mosaic & Terrazzo Workers	25.25	202.00	11.0		11.0		48.8	12.30	37.55	300.40
Pord	Painters, Ordinary	22.95	183.60	16.8		11.0		54.6	12.55	35.50	284.00
Psst	Painters, Structural Steel	23.95	191.60	62.5		11.0		100.3	24.00	47.95	383.60
Pape	Paper Hangers	23.30	186.40	16.8		11.0		54.6	12.70	36.00	288.00
Pile	Pile Drivers	25.35	202.80	33.6		16.0		76.4	19.35	44.70	357.60
Plas	Plasterers	24.20	193.60	17.4		11.0		55.2	13.35	37.55	300.40
Plah	Plasterer Helpers	20.15	161.20	17.4		11.0		55.2	11.10	31.25	250.00
Plum	Plumbers	30.05	240.40	10.2		16.0		53.0	15.95	46.00	368.00
Rodm	Rodmen (Reinforcing)	27.75	222.00	36.3		14.0		77.1	21.40	49.15	393.20
Rofc	Roofers, Composition	22.55	180.40	37.4		11.0		75.2	16.95	39.50	316.00
Rots	Roofers, Tile & Slate	22.60	180.80	37.4		11.0		75.2	17.00	39.60	316.80
Rohe	Roofers, Helpers (Composition)	15.95	127.60	37.4		11.0		75.2	12.00	27.95	223.60
Shee	Sheet Metal Workers	28.95	231.60	13.8		16.0		56.6	16.40	45.35	362.80
Spri	Sprinkler Installers	31.30	250.40	10.4		16.0		53.2	16.65	47.95	383.60
Stpi	Steamfitters or Pipefitters	30.30	242.40	10.2		16.0		53.0	16.05	46.35	370.80
Ston	Stone Masons	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Sswk	Structural Steel Workers	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Tilf	Tile Layers	25.05	200.40	11.0		11.0		48.8	12.20	37.25	298.00
Tilh	Tile Layers Helpers	20.30	162.40	11.0		11.0		48.8	9.90	30.20	241.60
Trlt	Truck Drivers, Light	20.35	162.80	17.0		11.0		54.8	11.15	31.50	252.00
Trhv	Truck Drivers, Heavy	20.70	165.60	17.0		11.0		54.8	11.35	32.05	256.40
Sswl	Welders, Structural Steel	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Wrck	*Wrecking	19.80	158.40	44.8		11.0		82.6	16.35	36.15	289.20

*Not included in Averages.

City Cost Indexes

	DIVISION	FLORIDA																	
		MIAMI			ORLANDO			PANAMA CITY			PENSACOLA			ST. PETERSBURG			TALLAHASSEE		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
	SITE WORK	110.3	72.8	81.5	125.3	85.9	95.0	141.6	83.4	96.9	138.9	85.9	98.1	126.2	85.6	95.0	125.7	85.2	94.6
031	CONCRETE FORMWORK	94.2	71.0	74.5	97.3	71.6	75.5	95.8	37.8	46.6	84.5	69.7	72.0	94.1	64.8	69.3	97.3	53.0	59.7
032	CONCRETE REINFORCEMENT	95.1	72.5	82.4	95.1	79.0	86.0	99.3	64.5	79.7	101.5	64.9	81.0	98.5	74.3	84.9	95.1	65.2	78.3
033	CAST IN PLACE CONCRETE	91.5	75.4	84.6	88.7	78.0	84.1	95.2	43.0	72.9	95.2	69.0	84.0	101.4	70.2	88.1	91.7	58.4	77.5
3	CONCRETE	87.4	74.3	80.8	86.3	76.7	81.4	95.0	46.6	70.5	93.5	70.1	81.7	92.6	70.1	81.2	87.7	59.2	73.3
4	MASONRY	76.9	70.2	72.8	77.4	75.6	76.2	84.9	37.4	55.4	82.6	67.6	73.3	119.2	66.9	86.7	83.6	52.6	64.4
5	METALS	98.8	93.5	96.8	107.9	95.0	103.0	97.2	75.1	88.9	97.1	89.6	94.3	101.0	92.4	97.7	99.2	88.1	95.0
6	WOOD & PLASTICS	88.6	72.7	80.6	94.5	71.1	82.8	92.9	38.3	65.6	80.1	71.1	75.6	90.8	65.2	78.0	94.5	51.6	73.0
7	THERMAL & MOISTURE PROTECTION	99.6	74.6	88.0	96.6	75.6	86.9	96.9	38.3	69.9	96.6	66.9	82.9	96.3	63.1	81.0	96.6	58.8	79.1
8	DOORS & WINDOWS	95.9	69.5	89.5	98.1	68.2	90.9	95.7	35.2	81.2	95.7	66.5	88.7	96.8	60.4	88.0	98.1	53.9	87.4
092	LATH, PLASTER & GYPSUM BOARD	101.0	72.5	82.5	101.6	70.8	81.7	99.7	36.9	59.0	94.5	70.9	79.2	98.9	64.8	76.8	101.6	50.7	68.6
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	72.5	83.0	102.4	70.8	82.0	96.6	36.9	58.0	96.6	70.9	79.9	98.0	64.8	76.5	102.4	50.7	68.9
096	FLOORING & CARPET	121.8	75.3	110.7	113.0	74.9	103.8	112.3	24.6	91.3	106.7	68.0	97.4	111.4	67.8	100.9	113.0	49.7	97.8
099	PAINTING & WALL COVERINGS	100.9	70.1	83.0	104.2	77.6	88.7	104.2	34.5	63.7	104.2	78.5	89.3	104.2	65.4	81.6	104.2	55.7	76.0
9	FINISHES	108.6	71.4	89.7	107.7	72.7	89.9	107.2	34.4	70.2	104.5	70.5	87.2	106.0	65.3	85.3	107.7	51.9	79.3
10-14	TOTAL DIV. 10-14	100.0	81.8	96.1	100.0	83.9	96.6	100.0	65.4	92.6	100.0	73.3	94.3	100.0	76.8	95.1	100.0	74.0	94.5
15	MECHANICAL	100.0	72.9	88.0	100.0	70.8	87.1	100.0	34.6	71.1	100.0	68.8	86.2	100.0	68.7	86.2	100.0	54.8	80.0
16	ELECTRICAL	98.0	84.9	89.3	98.0	63.0	74.6	96.3	47.1	63.5	101.8	63.4	76.2	98.5	68.1	78.2	98.0	58.3	71.5
1-16	WEIGHTED AVERAGE	97.5	76.7	87.4	99.2	75.1	87.6	99.2	48.1	74.5	98.8	71.8	85.7	101.0	71.8	86.9	98.5	62.1	80.9

	DIVISION	FLORIDA			GEORGIA														
		TAMPA			ALBANY			ATLANTA			AUGUSTA			COLUMBUS			MACON		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	126.9	85.6	95.1	110.4	74.2	82.5	114.3	92.8	97.8	110.2	91.5	95.8	110.4	74.3	82.6	111.6	91.9	96.5
031	CONCRETE FORMWORK	97.3	64.9	69.8	96.9	50.8	57.8	98.0	70.3	74.5	94.5	61.8	66.7	96.9	50.4	57.4	95.9	65.9	70.5
032	CONCRETE REINFORCEMENT	95.1	74.3	83.4	95.1	76.4	84.6	98.5	77.5	86.7	104.0	69.1	84.4	95.1	76.4	84.6	97.4	76.7	85.8
033	CAST IN PLACE CONCRETE	101.7	70.2	88.2	95.5	48.9	75.6	101.1	71.2	88.3	95.6	57.9	79.5	95.5	49.5	75.8	95.5	53.3	77.5
3	CONCRETE	92.4	70.2	81.2	89.4	57.0	73.0	94.0	72.1	82.9	90.5	62.2	76.2	89.4	57.0	73.0	89.7	65.1	77.3
4	MASONRY	82.8	66.9	72.9	83.4	38.9	55.7	92.1	63.6	74.4	92.2	49.1	65.4	83.4	39.3	56.0	98.6	46.7	66.4
	METALS	102.2	92.4	98.5	96.8	89.0	93.9	93.7	74.5	86.4	92.4	69.4	83.7	96.7	89.3	93.9	91.7	90.1	91.1
	WOOD & PLASTICS	94.5	65.2	79.8	93.7	51.6	72.6	99.7	72.2	86.0	95.9	64.6	80.3	93.7	51.3	72.5	97.4	69.9	83.6
7	THERMAL & MOISTURE PROTECTION	96.6	64.3	81.7	96.4	55.7	77.6	94.2	70.0	83.0	93.6	59.5	77.9	96.1	55.7	77.5	95.1	62.9	80.2
8	DOORS & WINDOWS	98.1	60.4	89.0	95.9	53.7	85.7	94.2	67.9	87.9	90.6	59.3	83.1	95.9	53.8	85.7	94.2	64.8	87.1
092	LATH, PLASTER & GYPSUM BOARD	101.6	64.8	77.7	101.6	50.7	68.6	112.5	72.0	86.2	111.3	64.1	80.7	101.6	50.4	68.4	108.3	69.5	83.2
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	64.8	78.1	102.4	50.7	69.0	108.7	72.0	84.9	108.7	64.1	79.8	102.4	50.4	68.7	95.9	69.5	78.8
096	FLOORING & CARPET	113.0	67.8	102.1	113.0	40.4	95.6	87.8	75.0	84.8	86.7	51.5	78.2	113.0	41.0	95.7	87.8	47.5	78.2
099	PAINTING & WALL COVERINGS	104.2	65.4	81.6	100.9	50.4	71.5	99.0	72.1	83.4	99.0	47.9	69.3	100.9	48.3	70.3	102.4	59.0	77.2
9	FINISHES	107.7	65.3	86.1	105.8	48.1	76.4	95.1	71.5	83.1	94.4	58.6	76.1	105.7	47.8	76.2	91.5	62.0	76.5
10-14	TOTAL DIV. 10-14	100.0	76.8	95.1	100.0	69.5	93.5	100.0	75.4	94.8	100.0	71.0	93.8	100.0	69.4	93.5	100.0	73.6	94.4
15	MECHANICAL	100.0	68.7	86.2	100.0	56.8	80.9	100.1	71.7	87.5	100.1	54.0	79.7	100.0	46.2	76.2	100.0	52.1	78.8
16	ELECTRICAL	97.5	68.1	77.9	93.3	68.1	76.5	93.4	82.3	86.0	96.9	61.3	73.2	93.3	49.4	64.0	91.4	63.3	72.7
1-16	WEIGHTED AVERAGE	99.5	71.8	86.1	97.1	60.8	79.5	96.5	75.0	86.1	95.5	62.5	79.5	97.1	55.7	77.1	95.4	65.4	80.9

	DIVISION	GEORGIA						HAWAII			IDAHO								
		SAVANNAH			VALDOSTA			HONOLULU			BOISE			LEWISTON			POCATELLO		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.6	76.1	84.0	122.0	74.5	85.5	115.0	112.0	112.7	86.4	99.3	96.3	90.4	92.7	92.2	89.1	99.3	96.9
031	CONCRETE FORMWORK	97.0	60.5	66.0	80.8	51.9	56.3	102.1	158.7	150.1	97.4	89.3	90.5	106.3	87.1	90.0	97.4	89.3	90.5
032	CONCRETE REINFORCEMENT	100.7	69.5	83.2	100.8	50.3	72.5	109.9	125.0	118.4	96.0	78.4	86.1	108.6	96.1	101.6	96.3	78.5	86.3
033	CAST IN PLACE CONCRETE	91.5	56.6	76.6	93.0	57.4	77.8	170.2	127.7	152.0	98.6	93.8	96.6	107.8	93.9	101.8	99.6	93.8	97.1
3	CONCRETE	88.3	62.5	75.3	92.8	55.5	74.0	153.0	139.4	146.1	103.2	88.7	95.9	115.5	91.0	103.1	103.7	88.6	96.1
4	MASONRY	86.9	57.6	68.7	89.8	50.6	65.4	131.3	134.3	133.2	131.8	81.0	100.2	128.8	96.6	108.8	136.3	82.7	103.0
5	METALS	97.1	87.6	93.5	96.5	80.7	90.6	117.4	107.6	113.7	112.9	82.2	101.3	96.2	90.7	94.1	112.5	82.2	101.1
6	WOOD & PLASTICS	93.8	60.9	77.3	76.0	50.3	63.1	100.6	165.6	133.1	95.1	88.5	91.8	98.7	83.6	91.2	95.1	88.5	91.8
7	THERMAL & MOISTURE PROTECTION	96.4	59.2	79.3	96.1	60.0	79.5	109.5	133.7	120.6	97.9	84.0	91.5	167.6	89.8	131.7	98.0	83.8	91.5
8	DOORS & WINDOWS	95.9	56.7	86.4	91.4	46.3	80.5	110.6	146.5	119.2	94.9	81.7	91.7	116.3	85.0	108.7	94.9	78.5	91.0
092	LATH, PLASTER & GYPSUM BOARD	101.6	60.4	74.9	93.7	49.4	65.0	95.7	167.7	142.3	89.0	87.9	88.3	135.3	83.0	101.4	89.0	87.9	88.3
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	60.4	75.2	98.0	49.4	66.5	132.8	167.7	155.4	96.2	87.9	90.8	144.9	83.0	104.8	96.2	87.9	90.8
096	FLOORING & CARPET	113.0	60.7	100.4	105.1	48.5	91.5	127.8	128.3	127.9	97.5	74.8	92.1	135.1	97.9	126.2	97.5	74.8	92.1
	PAINTING & WALL COVERINGS	100.9	59.9	77.0	100.9	43.7	67.6	123.8	148.0	137.9	109.4	67.9	85.2	134.4	91.3	109.3	109.4	78.2	91.3
	FINISHES	105.8	60.5	82.8	101.9	50.0	75.5	124.5	153.9	139.5	93.2	84.6	88.8	156.4	89.0	122.1	93.2	85.8	89.4
10-14	TOTAL DIV. 10-14	100.0	71.7	94.0	100.0	70.1	93.7	100.0	129.2	106.2	100.0	86.1	97.0	100.0	100.6	100.1	100.0	86.1	97.0
15	MECHANICAL	100.0	55.8	80.5	100.0	48.7	77.3	100.1	119.4	108.6	99.8	85.6	93.5	100.6	94.1	97.7	99.8	85.6	93.5
16	ELECTRICAL	93.3	65.4	74.7	90.2	40.8	57.2	109.7	128.8	122.5	85.2	78.7	80.9	87.5	92.2	90.6	85.7	79.4	81.5
1-16	WEIGHTED AVERAGE	97.2	64.6	81.4	96.8	55.0	76.6	115.9	129.5	122.5	101.0	85.2	93.4	111.9	92.1	102.3	101.3	85.5	93.7

A.3.5-16

ECO NUMBER 6

REPAIR BUILDING SIDE DHW AND HVAC HOT WATER LEAKS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-6 REPAIR DHW AND HHW LEAKS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 1448.			
B. SIOH	$ 87.			
C. DESIGN COST	$ 87.			
D. TOTAL COST (1A+1B+1C)	$ 1622.			
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.		
F. PUBLIC UTILITY COMPANY REBATE		$ 0.		
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 1622.	

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1111.	$ 1489.	14.88	$ 22152.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1111.	$ 1489.		$ 22152.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 530.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7886.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 7886.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2019.

5. SIMPLE PAYBACK PERIOD (1G/4) .80 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 30039.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 18.52
(IF < 1 PROJECT DOES NOT QUALIFY)

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Repair DHW and HHW Leaks	Date:	02/08/96
ECO Number:	6		

Assumptions:	1. HHW temperature	180	°F
	2. Make-up water temperature	70	°F
	3. Condensate temperature	200	°F
	4. Boiler efficiency	68%	
	5. Average heating fuel cost	$1.34	/MBtu
	6. Water cost	$0.5562	/kGallons

Bldg.	Leak	Location	Cup/Min	Drop/Sec	GPM	Temp.,°F	MBtu/Yr	
218	DHW	from circ. pump	1.0		0.0625	124	14.8	
512	COND	from T at cond. tank		10.0	0.0250	200	14.2	
515	DHW	from circ. pump		1.0	0.0025	123	0.6	
516	DHW	from relief valve	6.0		0.3750	125	90.4	
518	DHW	from relief valve	3.5		0.2188	183	108.4	
624	COND	from near cond. tank		12.0	0.0300	200	17.1	
629	HHW	from relief valve	6.0		0.3750	211	231.8	
630	HHW	from relief valve		0.2	0.0005	180	0.2	
630	HHW	from air separator		0.4	0.0010	180	0.5	
631	HHW	supply side of ht ex		1.0	0.0025	180	1.2	
633	HHW	from relief valve		1.0	0.0025	180	1.2	
636	DHW	from HWG drain pipe		15.0	0.0375	138	11.2	
638	HHW	from circ. pump		0.3	0.0008	180	0.4	
642	DHW	from pipe above tank		5.0	0.0125	154	4.6	
644	HHW	from relief valve	1.1		0.0703	180	33.9	
648	HHW	from relief valve		1.0	0.0025	180	1.2	
706	HHW	from circ. pump		3.0	0.0075	180	3.6	
708	HHW	from relief valve		5.0	0.0125	180	6.0	
708	DHW	from relief valve	1.0		0.0625	131	16.7	
722	HHW	from circ. pump		2.0	0.0050	200	2.8	
726	COND	at cond. tank		1.0	0.0025	200	1.4	
726	DHW	from circ. pump		5.0	0.0125	158	4.8	
814	HHW	from circ. pump		3.0	0.0075	180	3.6	
816	HHW	from drain valve		0.1	0.0003	180	0.1	
1208	HHW	from drain valve		0.2	0.0005	180	0.2	
1245	HHW	from circ. pump		1.0	0.0025	180	1.2	
1280	HHW	from relief valve	7.0		0.4375	150	153.4	
1509	HHW	from relief valve	2.1		0.1328	180	64.0	
1840	HHW	from circ. pump		1.0	0.0025	180	1.2	
29		Current HTW Losses	27.8	68.2	1.9049	GPM	791.0	MBtu/Yr
			x 1.00	x 0.50				
		Proposed HTW Savings	27.8	34.1	1.8196	GPM	755.6	MBtu/Yr
		Proposed HTW Losses			0.0853	GPM	35.4	MBtu/Yr

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

Current Fuel Use =	791.0 MBtu/yr	/	0.68	=	1163.2	MBtu/Yr
Current Fuel Cost =	1163.2 MBtu/yr	x	$1.34 /MBtu	=	$1,559	/Year
New Fuel Use =	35.4 MBtu/yr	/	0.68	=	52.1	MBtu/Yr
New Fuel Cost =	52.1 MBtu/yr	x	$1.34 /MBtu	=	$70	/Year

Water Cost:

Current water cost =	1001224 Gal/Yr	x	$0.5562 /kGal	=	$557	/Year
New water cost =	44818 Gal/Yr	x	$0.5562 /kGal	=	$25	/Year

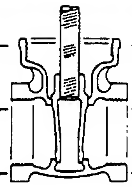
CONSTRUCTION COST ESTIMATE

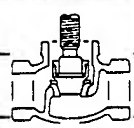
Project:	Repair DHW and HHW Leaks in Mechanical Rooms	RS&H No.:	694-1331-002
Location:	Fort Stewart, GA	Date:	02/14/96
Basis:	Schematic Design	Estimator:	W.T.Todd
ECO No.:	6	Filename:	EST-6.WQ1

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Travel time to bldgs.	4.3	hr		0	30.3	131	131		(1)
Repair/tighten fittings	6.0	hr		0	30.3	182	182		(2)
Remove P&T valves	11	Ea		0	10	110	110		MMp188
1" P & T relief valve	11	Ea	79	869	10	110	979	MMp188	MMp188
Subtotal Bare Costs				869		533	$1,402		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				869		533	1,402		
City Cost Index (Sav. GA)			0%	0	-44%	-236	(236)	MMp533	MMp533
Subtotal				869		297	1,166		
OH & Profit Markups			10%	87	53%	157	244	MMp7	MMp475
Subtotal				956		454	1,410		
Sales Taxes			4.0%	38		NA	38	MMp476	
Total Construction Cost				994		454	1,448		
Design Fee				NA	6.0%	87	87		
SIOH				NA	6.0%	87	87		
Subtotal				994		628	1,622		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				994		628	$1,622		

LEGEND:

(1)	Estimate 10 minutes per building for 26 buildings.
(2)	Estimate 20 minutes per fitting for 18 fittings.
MMp###	1996 Means Mechanical Cost Data, page ###.





151 950 Valves		CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
955 3420	3/8" size R151-090	1 Plum	24	.333	Ea.	18.50	10		28.50	36 955
3430	1/2" size		24	.333		16.65	10		26.65	33.50
3440	3/4" size		20	.400		19.80	12		31.80	40.50
3450	1" size		19	.421		26	12.65		38.65	48
3460	1-1/4" size		15	.533		35	16.05		51.05	63
3470	1-1/2" size		13	.615		43	18.50		61.50	76
3480	2" size		11	.727		59.50	22		81.50	99
3490	2-1/2" size	Q-1	15	1.067		138	29		167	196
3500	3" size	"	13	1.231		195	33.50		228.50	266
3850	Rising stem, soldered, 300 psi									
3900	3/8" size	1 Plum	24	.333	Ea.	25	10		35	43
3920	1/2" size		24	.333		29	10		39	47.50
3940	3/4" size		20	.400		37.50	12		49.50	60
3950	1" size		19	.421		41	12.65		53.65	65
3960	1-1/4" size		15	.533		69	16.05		85.05	100
3970	1-1/2" size		13	.615		78.50	18.50		97	115
3980	2" size		11	.727		110	22		132	155
3990	2-1/2" size	Q-1	15	1.067		251	29		280	320
4000	3" size	"	13	1.231		350	33.50		383.50	435
4250	Threaded, class 150									
4310	1/4" size	1 Plum	24	.333	Ea.	16.85	10		26.85	34
4320	3/8" size		24	.333		16.85	10		26.85	34
4330	1/2" size		24	.333		16	10		26	33
4340	3/4" size		20	.400		19.10	12		31.10	39.50
4350	1" size		19	.421		25	12.65		37.65	47
4360	1-1/4" size		15	.533		34	16.05		50.05	62
4370	1-1/2" size		13	.615		41.50	18.50		60	74
4380	2" size		11	.727		57.50	22		79.50	97
4390	2-1/2" size	Q-1	15	1.067		133	29		162	190
4400	3" size	"	13	1.231		187	33.50		220.50	257
4500	For 300 psi, threaded, add					100%	15%			
4540	For chain operated type, add					15%				
4850	Globe, class 150, rising stem, threaded									
4920	1/4" size	1 Plum	24	.333	Ea.	23.50	10		33.50	41.50
4940	3/8" size		24	.333		23.50	10		33.50	41.50
4950	1/2" size		24	.333		23.50	10		33.50	41.50
4960	3/4" size		20	.400		32	12		44	53.50
4970	1" size		19	.421		50	12.65		62.65	74.50
4980	1-1/4" size		15	.533		78.50	16.05		94.55	111
4990	1-1/2" size		13	.615		94.50	18.50		113	133
5000	2" size		11	.727		143	22		165	191
5010	2-1/2" size	Q-1	15	1.067		287	29		316	360
5020	3" size	"	13	1.231		410	33.50		443.50	500
5120	For class 300, threaded, add					50%	15%			
5130	Globe, 300 lb., sweat, 3/8" size	1 Plum	24	.333		26	10		36	44
5140	1/2" size		24	.333		26	10		36	44
5150	3/4" size		20	.400		38	12		50	60.50
5160	1" size		19	.421		57	12.65		69.65	82
5170	1-1/4" size		15	.533		87	16.05		103.05	120
5180	1-1/2" size		13	.615		104	18.50		122.50	143
5190	2" size		11	.727		157	22		179	207
5200	2-1/2" size	Q-1	15	1.067		345	29		374	425
5210	3" size	"	13	1.231		505	33.50		538.50	605
5600	Relief, pressure & temperature, self-closing, ASME									
5640	3/4" size	1 Plum	28	.286	Ea.	51.50	8.60		60.10	69.50
5650	1" size		24	.333		79	10		89	102

15 MECHANICAL

A.3.6-5

Installing Contractor's Overhead & Profit

Below are the **average** installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

Column A: Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

Column B: Workers' Compensation rates are the national average of state rates established for each trade.

Column C: Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

Columns D and E: Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

Column F: Column F lists the total of Columns B, C, D, and E.

Column G: Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

Column H: Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

Column I: Column I is Column H multiplied by eight hours.

		A		B	C	D	E	F	G	H	I
		Base Rate Incl. Fringes		Workers' Comp. Ins.	Average Fixed Overhead	Overhead	Profit	Total Overhead & Profit		Rate with O & P	
Abbr.	Trade	Hourly	Daily					%	Amount	Hourly	Daily
Skwk	Skilled Workers Average (35 trades)	$25.95	$207.60	20.2%	16.8%	13.0%	10%	60.0%	$15.55	$41.50	$332.00
	Helpers Average (5 trades)	19.25	154.00	21.4		11.0		59.2	11.40	30.65	245.20
	Foreman Average, Inside ($.50 over trade)	26.45	211.60	20.2		13.0		60.0	15.85	42.30	338.40
	Foreman Average, Outside ($2.00 over trade)	27.95	223.60	20.2		13.0		60.0	16.75	44.70	357.60
Clab	Common Building Laborers	19.80	158.40	21.9		11.0		59.7	11.80	31.60	252.80
Asbe	Asbestos Workers	28.55	228.40	19.7		16.0		62.5	17.85	46.40	371.20
Boil	Boilermakers	30.05	240.40	17.7		16.0		60.5	18.20	48.25	386.00
Bric	Bricklayers	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Brhe	Bricklayer Helpers	20.00	160.00	19.4		11.0		57.2	11.45	31.45	251.60
Carp	Carpenters	25.20	201.60	21.9		11.0		59.7	15.05	40.25	322.00
Cefi	Cement Finishers	24.35	194.80	12.8		11.0		50.6	12.30	36.65	293.20
Elec	Electricians	29.30	234.40	8.0		16.0		50.8	14.90	44.20	353.60
Elev	Elevator Constructors	30.05	240.40	9.6		16.0		52.4	15.75	45.80	366.40
Eqhv	Equipment Operators, Crane or Shovel	26.75	214.00	12.9		14.0		53.7	14.35	41.10	328.80
Eqmd	Equipment Operators, Medium Equipment	25.70	205.60	12.9		14.0		53.7	13.80	39.50	316.00
Eqlt	Equipment Operators, Light Equipment	24.70	197.60	12.9		14.0		53.7	13.25	37.95	303.60
Eqol	Equipment Operators, Oilers	21.90	175.20	12.9		14.0		53.7	11.75	33.65	269.20
Eqmm	Equipment Operators, Master Mechanics	27.55	220.40	12.9		14.0		53.7	14.80	42.35	338.80
Glaz	Glaziers	24.90	199.20	16.0		11.0		53.8	13.40	38.30	306.40
Lath	Lathers	24.95	199.60	13.5		11.0		51.3	12.80	37.75	302.00
Marb	Marble Setters	25.65	205.20	19.4		11.0		57.2	14.65	40.30	322.40
Mill	Millwrights	26.55	212.40	13.2		11.0		51.0	13.55	40.10	320.80
Mstz	Mosaic & Terrazzo Workers	25.25	202.00	11.0		11.0		48.8	12.30	37.55	300.40
Pord	Painters, Ordinary	22.95	183.60	16.8		11.0		54.6	12.55	35.50	284.00
Psst	Painters, Structural Steel	23.95	191.60	62.5		11.0		100.3	24.00	47.95	383.60
Pape	Paper Hangers	23.30	186.40	16.8		11.0		54.6	12.70	36.00	288.00
Pile	Pile Drivers	25.35	202.80	33.6		16.0		76.4	19.35	44.70	357.60
Plas	Plasterers	24.20	193.60	17.4		11.0		55.2	13.35	37.55	300.40
Plah	Plasterer Helpers	20.15	161.20	17.4		11.0		55.2	11.10	31.25	250.00
Plum	Plumbers	30.05	240.40	10.2		16.0		53.0	15.95	46.00	368.00
Rodm	Rodmen (Reinforcing)	27.75	222.00	36.3		14.0		77.1	21.40	49.15	393.20
Rofc	Roofers, Composition	22.55	180.40	37.4		11.0		75.2	16.95	39.50	316.00
Rots	Roofers, Tile & Slate	22.60	180.80	37.4		11.0		75.2	17.00	39.60	316.80
Rohe	Roofers, Helpers (Composition)	15.95	127.60	37.4		11.0		75.2	12.00	27.95	223.60
Shee	Sheet Metal Workers	28.95	231.60	13.8		16.0		56.6	16.40	45.35	362.80
Spri	Sprinkler Installers	31.30	250.40	10.4		16.0		53.2	16.65	47.95	383.60
Stpi	Steamfitters or Pipefitters	30.30	242.40	10.2		16.0		53.0	16.05	46.35	370.80
Ston	Stone Masons	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Sswk	Structural Steel Workers	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Tilf	Tile Layers	25.05	200.40	11.0		11.0		48.8	12.20	37.25	298.00
Tilh	Tile Layers Helpers	20.30	162.40	11.0		11.0		48.8	9.90	30.20	241.60
Trlt	Truck Drivers, Light	20.35	162.80	17.0		11.0		54.8	11.15	31.50	252.00
Trhv	Truck Drivers, Heavy	20.70	165.60	17.0		11.0		54.8	11.35	32.05	256.40
Sswl	Welders, Structural Steel	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Wrck	*Wrecking	19.80	158.40	44.8		11.0		82.6	16.35	36.15	289.20

*Not included in Averages.

City Cost Indexes

	DIVISION	FLORIDA																	
		MIAMI			ORLANDO			PANAMA CITY			PENSACOLA			ST. PETERSBURG			TALLAHASSEE		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.3	72.8	81.5	125.3	85.9	95.0	141.6	83.4	96.9	138.9	85.9	98.1	126.2	85.6	95.0	125.7	85.2	94.6
031	CONCRETE FORMWORK	94.2	71.0	74.5	97.3	71.6	75.5	95.8	37.8	46.6	84.5	69.7	72.0	94.1	64.8	69.3	97.3	53.0	59.7
032	CONCRETE REINFORCEMENT	95.1	72.5	82.4	95.1	79.0	86.0	99.3	64.5	79.7	101.5	64.9	81.0	98.5	74.3	84.9	95.1	65.2	78.3
033	CAST IN PLACE CONCRETE	91.5	75.4	84.6	88.7	78.0	84.1	95.2	43.0	72.9	95.2	69.0	84.0	101.4	70.2	88.1	91.7	58.4	77.5
3	CONCRETE	87.4	74.3	80.8	86.3	76.7	81.4	95.0	46.6	70.5	93.5	70.1	81.7	92.6	70.1	81.2	87.7	59.2	73.3
4	MASONRY	76.9	70.2	72.8	77.4	75.6	76.2	84.9	37.4	55.4	82.6	67.6	73.3	119.2	66.9	86.7	83.6	52.6	64.4
5	METALS	98.8	93.5	96.8	107.9	95.0	103.0	97.2	75.1	88.9	97.1	89.6	94.3	101.0	92.4	97.7	99.2	88.1	95.0
6	WOOD & PLASTICS	88.6	72.7	80.6	94.5	71.1	82.8	92.9	38.3	65.6	80.1	71.1	75.6	90.8	65.2	78.0	94.5	51.6	73.0
7	THERMAL & MOISTURE PROTECTION	99.6	74.6	88.0	96.6	75.6	86.9	96.9	38.3	69.9	96.6	66.9	82.9	96.3	63.1	81.0	96.6	58.8	79.1
8	DOORS & WINDOWS	95.9	69.5	89.5	98.1	68.2	90.9	95.7	35.2	81.2	95.7	66.5	88.7	96.8	60.4	88.0	98.1	53.9	87.4
092	LATH, PLASTER & GYPSUM BOARD	101.0	72.5	82.5	101.6	70.8	81.7	99.7	36.9	59.0	94.5	70.9	79.2	98.9	64.8	76.8	101.6	50.7	68.6
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	72.5	83.0	102.4	70.8	82.0	96.6	36.9	58.0	96.6	70.9	79.9	98.0	64.8	76.5	102.4	50.7	68.9
096	FLOORING & CARPET	121.8	75.3	110.7	113.0	74.9	103.8	112.3	24.6	91.3	106.7	68.0	97.4	111.4	67.8	100.9	113.0	49.7	97.8
099	PAINTING & WALL COVERINGS	100.9	70.1	83.0	104.2	77.6	88.7	104.2	34.5	63.7	104.2	78.5	89.3	104.2	65.4	81.6	104.2	55.7	76.0
9	FINISHES	108.6	71.4	89.7	107.7	72.7	89.9	107.2	34.4	70.2	104.5	70.5	87.2	106.0	65.3	85.3	107.7	51.9	79.3
10-14	TOTAL DIV. 10-14	100.0	81.8	96.1	100.0	83.9	96.6	100.0	65.4	92.6	100.0	73.3	94.3	100.0	76.8	95.1	100.0	74.0	94.5
15	MECHANICAL	100.0	72.9	88.0	100.0	70.8	87.1	100.0	34.6	71.1	100.0	68.8	86.2	100.0	68.7	86.2	100.0	54.8	80.0
16	ELECTRICAL	98.0	84.9	89.3	98.0	63.0	74.6	96.3	47.1	63.5	101.8	63.4	76.2	98.5	68.1	78.2	98.0	58.3	71.5
1-16	WEIGHTED AVERAGE	97.5	76.7	87.4	99.2	75.1	87.6	99.2	48.1	74.5	98.8	71.8	85.7	101.0	71.8	86.9	98.5	62.1	80.9

	DIVISION	FLORIDA			GEORGIA														
		TAMPA			ALBANY			ATLANTA			AUGUSTA			COLUMBUS			MACON		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	126.9	85.6	95.1	110.4	74.2	82.5	114.3	92.8	97.8	110.2	91.5	95.8	110.4	74.3	82.6	111.6	91.9	96.5
031	CONCRETE FORMWORK	97.3	64.9	69.8	96.9	50.8	57.8	98.0	70.3	74.5	94.5	61.8	66.7	96.9	50.4	57.4	95.9	65.9	70.5
032	CONCRETE REINFORCEMENT	95.1	74.3	83.4	95.1	76.4	84.6	98.5	77.5	86.7	104.0	69.1	84.4	95.1	76.4	84.6	97.4	76.7	85.8
033	CAST IN PLACE CONCRETE	101.7	70.2	88.2	95.5	48.9	75.6	101.1	71.2	88.3	95.6	57.9	79.5	95.5	49.5	75.8	95.5	53.3	77.5
3	CONCRETE	92.4	70.2	81.2	89.4	57.0	73.0	94.0	72.1	82.9	90.5	62.2	76.2	89.4	57.0	73.0	89.7	65.1	77.3
4	MASONRY	82.8	66.9	72.9	83.4	38.9	55.7	92.1	63.6	74.4	92.2	49.1	65.4	83.4	39.3	56.0	98.6	46.7	66.4
5	METALS	102.2	92.4	98.5	96.8	89.0	93.9	93.7	74.5	86.4	92.4	69.4	83.7	96.7	89.3	93.9	91.7	90.1	91.1
6	WOOD & PLASTICS	94.5	65.2	79.8	93.7	51.6	72.6	99.7	72.2	86.0	95.9	64.6	80.3	93.7	51.3	72.5	97.4	69.9	83.6
7	THERMAL & MOISTURE PROTECTION	96.6	64.3	81.7	96.4	55.7	77.6	94.2	70.0	83.0	93.6	59.5	77.9	96.1	55.7	77.5	95.1	62.9	80.2
8	DOORS & WINDOWS	98.1	60.4	89.0	95.9	53.7	85.7	94.2	67.9	87.9	90.6	59.3	83.1	95.9	53.8	85.7	94.2	64.8	87.1
092	LATH, PLASTER & GYPSUM BOARD	101.6	64.8	77.7	101.6	50.7	68.6	112.5	72.0	86.2	111.3	64.1	80.7	101.6	50.4	68.4	108.3	69.5	83.2
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	64.8	78.1	102.4	50.7	69.0	108.7	72.0	84.9	108.7	64.1	79.8	102.4	50.4	68.7	95.9	69.5	78.8
096	FLOORING & CARPET	113.0	67.8	102.1	113.0	40.4	95.6	87.8	75.0	84.8	86.7	51.5	78.2	113.0	41.0	95.7	87.8	47.5	78.2
099	PAINTING & WALL COVERINGS	104.2	65.4	81.6	100.9	50.4	71.5	99.0	72.1	83.4	99.0	47.9	69.3	100.9	48.3	70.3	102.4	59.0	77.2
9	FINISHES	107.7	65.3	86.1	105.8	48.1	76.4	95.1	71.5	83.1	94.4	58.6	76.1	105.7	47.8	76.2	91.5	62.0	76.5
10-14	TOTAL DIV. 10-14	100.0	76.8	95.1	100.0	69.5	93.5	100.0	75.4	94.8	100.0	71.0	93.8	100.0	69.4	93.5	100.0	73.6	94.4
15	MECHANICAL	100.0	68.7	86.2	100.0	56.8	80.9	100.1	71.7	87.5	100.1	54.0	79.7	100.0	46.2	76.2	100.0	52.1	78.8
16	ELECTRICAL	97.5	68.1	77.9	93.3	68.1	76.5	93.4	82.3	86.0	96.9	61.3	73.2	93.3	49.4	64.0	91.4	63.3	72.7
1-16	WEIGHTED AVERAGE	99.5	71.8	86.1	97.1	60.8	79.5	96.5	75.0	86.1	95.5	62.5	79.5	97.1	55.7	77.1	95.4	65.4	80.9

	DIVISION	GEORGIA						HAWAII			IDAHO								
		SAVANNAH			VALDOSTA			HONOLULU			BOISE			LEWISTON			POCATELLO		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.6	76.1	84.0	122.0	74.5	85.5	115.0	112.0	112.7	86.4	99.3	96.3	90.4	92.7	92.2	89.1	99.3	96.9
031	CONCRETE FORMWORK	97.0	60.5	66.0	80.8	51.9	56.3	102.1	158.7	150.1	97.4	89.3	90.5	106.3	87.1	90.0	97.4	89.3	90.5
032	CONCRETE REINFORCEMENT	100.7	69.5	83.2	100.8	50.3	72.5	109.9	125.0	118.4	96.0	78.4	86.1	108.6	96.1	101.6	96.3	78.5	86.3
033	CAST IN PLACE CONCRETE	91.5	56.6	76.6	93.0	57.4	77.8	170.2	127.7	152.0	98.6	93.8	96.6	107.8	93.9	101.8	99.6	93.8	97.1
3	CONCRETE	88.3	62.5	75.3	92.8	55.5	74.0	153.0	139.4	146.1	103.2	88.7	95.9	115.5	91.0	103.1	103.7	88.6	96.1
4	MASONRY	86.9	57.6	68.7	89.8	50.6	65.4	131.3	134.3	133.2	131.8	81.0	100.2	128.8	96.6	108.8	136.3	82.7	103.0
5	METALS	97.1	87.6	93.5	96.5	80.7	90.6	117.4	107.6	113.7	112.9	82.2	101.3	96.2	90.7	94.1	112.5	82.2	101.1
6	WOOD & PLASTICS	93.8	60.9	77.3	76.0	50.3	63.1	100.6	165.6	133.1	95.1	88.5	91.8	98.7	83.6	91.2	95.1	88.5	91.8
7	THERMAL & MOISTURE PROTECTION	96.4	59.2	79.3	96.1	60.0	79.5	109.5	133.7	120.6	97.9	84.0	91.5	167.6	89.8	131.7	98.0	83.8	91.5
8	DOORS & WINDOWS	95.9	56.7	86.4	91.4	46.3	80.5	110.6	146.5	119.2	94.9	81.7	91.7	116.3	85.0	108.7	94.9	78.5	91.0
092	LATH, PLASTER & GYPSUM BOARD	101.6	60.4	74.9	93.7	49.4	65.0	95.7	167.7	142.3	89.0	87.9	88.3	135.3	83.0	101.4	89.0	87.9	88.3
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	60.4	75.2	98.0	49.4	66.5	132.8	167.7	155.4	96.2	87.9	90.8	144.9	83.0	104.8	96.2	87.9	90.8
096	FLOORING & CARPET	113.0	60.7	100.4	105.1	48.5	91.5	127.8	128.3	127.9	97.5	74.8	92.1	135.1	97.9	126.2	97.5	74.8	92.1
099	PAINTING & WALL COVERINGS	100.9	59.9	77.0	100.9	43.7	67.6	123.8	148.0	137.9	109.4	67.9	85.2	134.4	91.3	109.3	109.4	78.2	91.3
9	FINISHES	105.8	60.5	82.8	101.9	50.0	75.5	124.5	153.9	139.5	93.2	84.6	88.8	156.4	89.0	122.1	93.2	85.8	89.4
10-14	TOTAL DIV. 10-14	100.0	71.7	94.0	100.0	70.1	93.7	100.0	129.2	106.2	100.0	86.1	97.0	100.0	100.6	100.1	100.0	86.1	97.0
15	MECHANICAL	100.0	55.8	80.5	100.0	48.7	77.3	100.1	119.4	108.6	99.8	85.6	93.5	100.6	94.1	97.7	99.8	85.6	93.5
16	ELECTRICAL	93.3	65.4	74.7	90.2	40.8	57.2	109.7	128.8	122.5	85.2	78.7	80.9	87.5	92.2	90.6	85.7	79.4	81.5
1-16	WEIGHTED AVERAGE	97.2	64.6	81.4	96.8	55.0	76.6	115.9	129.5	122.5	101.0	85.2	93.4	111.9	92.1	102.3	101.3	85.5	93.7

A.3.6-7

ECO NUMBER 7

REPAIR HTW LEAKS IN VALVE PITS

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-7
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-7 REPAIR HTW LEAKS IN VALVE PITS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 2480.
B. SIOH $ 149.
C. DESIGN COST $ 149.
D. TOTAL COST (1A+1B+1C) $ 2778.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 2778.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 33.	15.08	$ 497.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1873.	$ 2510.	14.88	$ 37346.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1875.	$ 2543.		$ 37843.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 275.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4092.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 4092.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 2818.

5. SIMPLE PAYBACK PERIOD (1G/4) .99 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 41935.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 15.10
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-7X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-7 REPAIR HTW LEAKS IN VALVE PITS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 2480.		
B. SIOH	$ 149.		
C. DESIGN COST	$ 149.		
D. TOTAL COST (1A+1B+1C)	$ 2778.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 2778.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 33.	15.08	$ 497.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1619.	$ 2169.	14.88	$ 32282.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1621.	$ 2202.		$ 32779.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 275.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4092.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4092.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2477.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.12 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 36871.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 13.27
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO's 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-7Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-7 REPAIR HTW LEAKS IN VALVE PITS
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 2480.
B. SIOH $ 149.
C. DESIGN COST $ 149.
D. TOTAL COST (1A+1B+1C) $ 2778.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 2778.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	2.	$ 33.	15.08	$ 497.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	1432.	$ 1919.	14.88	$ 28553.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		1434.	$ 1952.		$ 29050.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 275.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4092.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4092.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 2227.

5. SIMPLE PAYBACK PERIOD (1G/4) 1.25 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 33142.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 11.93
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT: FORT STEWART
REPAIR LEAKS IN VALVE PITS
DESIGNER: W. TODD
CHECKER:

AEP NO: 694 1331 002
SHEET: OF:
DATE: 2-8-96
DATE:

ECO-7 SUMMARY

ANNUAL SAVINGS

ELECTRICITY = 2.5 - 0.1 = $\boxed{2.4 \text{ mBtu/YR}}$

HEATING FUELS = 1942 - 69 = $\boxed{1873 \text{ mBtu/YR}}$

WATER = \$284 - \$10 = $\boxed{\$274\text{/YR}}$

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Existing Leaks in Valve Pits	Date:	02/08/96
ECO Number:	7		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

510360 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 1320.3 MBtu/Yr

Heating Fuel Use = 1320.3 MBtu/yr / 0.68 = 1941.6 MBtu/Yr

Heating Fuel Cost = 1941.6 MBtu/yr x $1.34 /MBtu = $2,602 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.97 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.10 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.10 BHP / 0.90 x 0.746 kW/HP = 0.08 kW

Electricity Use = 0.08 kW x 8760 Hr/Yr = 742 kWh/Yr

Electricity Use = 742 kWh/Yr x 0.003413 MBtu/kWh = 2.5 MBtu/Yr

Electricity Cost = 742 kWh/Yr x $0.0469 /kWh = $35 /Year

Water Cost:

510360 Gal/Yr x $0.5562 /kGal = $284 /Year

Total Utility Cost:

Heating Fuel Cost	$2,602	/Year
Pumping (Elec) Cost	$35	/Year
Water Cost	$284	/Year
Total Utility Cost	$2,921	/Year

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Repair Leaks in Valve Pits	Date:	02/08/96
ECO Number:	7		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

18130 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 46.9 MBtu/Yr

Heating Fuel Use = 46.9 MBtu/yr / 0.68 = 69.0 MBtu/Yr

Heating Fuel Cost = 69.0 MBtu/yr x $1.34 /MBtu = $92 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.03 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.00 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.00 BHP / 0.90 x 0.746 kW/HP = 0.00 kW

Electricity Use = 0.00 kW x 8760 Hr/Yr = 26 kWh/Yr

Electricity Use = 26 kWh/Yr x 0.003413 MBtu/kWh = 0.1 MBtu/Yr

Electricity Cost = 26 kWh/Yr x $0.0469 /kWh = $1 /Year

Water Cost:

18130 Gal/Yr x $0.5562 /kGal = $10 /Year

Total Utility Cost:

Heating Fuel Cost	$92	/Year
Pumping (Elec) Cost	$1	/Year
Water Cost	$10	/Year
Total Utility Cost	$103	/Year

RS&H

SUBJECT Fort Stewart
Repair Leaks in Valve Pits
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET ___ OF ___
DATE 2-5-96
DATE

Valve Pit No. / Near	Drops / Sec	Stream Dia. / GPM	Leak From
VP-1-11 / 704	1/3	– –	Valve
VP-1-16 / 726	3+2	– –	↓
VP-2N-5 / 1820	5+	– –	↓
VP-2S-1 / 6th St.	2	– –	↓
VP-2S-3 / 517	2	– –	↓
VP-2S-8 / 512	2+2	– –	2 valves
VP-3-1 / 1540	2	1/4" / 0.438	Flange
VP-3-5 / 1170	1/10 + 2	– –	Valve
VP-3-11 / 419	–	1/8" / 0.109	"
VP-3-15 / 200 blk Field	–	1/8" / 0.109	Flange
VP-3-16 / 225	–	3/16" / 0.246	↓
VP-3-18 / 218	2	– –	↓
VP-3-27 / 213	1+2	– –	↓
Totals 13 Pits	27.4 D/s	0.902 GPM	

Minor Leaks:

$$27.4 \text{ drop/s} \times 2.5 \times 10^{-3} \frac{\text{GPM}}{\text{d/s}} = 0.069 \text{ GPM} = 36{,}270 \frac{\text{GAL}}{\text{YR}}$$

Proposed HTW losses: Assume 50% of minor leaks

$$0.069 \text{ GPM} \times 1440 \frac{\text{min}}{\text{day}} \times 365 \frac{\text{day}}{\text{YR}} \times 0.5 = \underline{18130 \frac{\text{GAL}}{\text{YR}}}$$

Major Leaks: (Assume 100% can be repaired)

$$0.902 \text{ GPM} \times 1440 \text{ min/day} \times 365 \text{ day/YR} = 474{,}090 \text{ GAL/YR}$$

Current HTW Losses:

$$474090 \text{ GAL/YR} + 36270 \text{ GAL/YR} = \underline{510{,}360 \text{ GAL/YR}}$$

CONSTRUCTION COST ESTIMATE

Project: Repair HTW Leaks in Valve Pits
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 7

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-7.WQ1

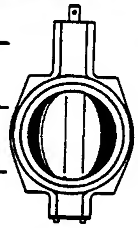
ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Travel time to bldgs.	2.2	hr		0	30.3	66	66		(1)
Repair/tighten valves	1.8	hr		0	30.3	53	53		(2)
Repair/tighten flanges	1.3	hr		0	30.3	38	38		(3)
Remove valves (4)	2	Ea		0	217.8	436	436		MMp191
6" gate valve, 250 lb (4)	2	Ea	700	1400	217.8	436	1,836	MMp191	MMp191
Subtotal Bare Costs				1400		1029	$2,429		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				1400		1029	2,429		
City Cost Index (Sav. GA)			0%	0	-44%	-455	(455)	MMp533	MMp533
Subtotal				1400		574	1,974		
OH & Profit Markups			10%	140	53%	304	444	MMp7	MMp475
Subtotal				1540		878	2,418		
Sales Taxes			4.0%	62		NA	62	MMp476	
Total Construction Cost				1602		878	2,480		
Design Fee				NA	6.0%	149	149		
SIOH				NA	6.0%	149	149		
Subtotal				1602		1176	2,778		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				1602		1176	$2,778		

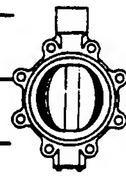
LEGEND:

(1) Estimate 10 minutes per valve pit for 13 valve pits.
(2) Estimate 15 minutes per valve for 7 valves (also see note 4).
(3) Estimate 15 minutes per flange for 5 flanges.
(4) Assumes 25 % of the 9 leaking valves will be replaced.
MMp### 1996 Means Mechanical Cost Data, page ###.

151 950 | Valves

R151 -090





			Crew	Daily Output	Labor-Hours	Unit	1996 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P	
960	1050	3" size	Q-1	8	2	Ea.	175	54		229	276	960
	1060	4" size		5	3.200		215	86.50		301.50	370	
	1070	5" size	Q-2	5	4.800		250	135		385	480	
	1080	6" size		5	4.800		273	135		408	505	
	1090	8" size		4.50	5.333		360	150		510	625	
	1100	10" size		4	6		415	168		583	715	
	1110	12" size		3	8		570	224		794	970	
	1200	Lug type, lever actuator										
	1220	2" size	1 Plum	14	.571	Ea.	87	17.15		104.15	122	
	1230	2-1/2" size	Q-1	9	1.778		89	48		137	172	
	1240	3" size		8	2		95	54		149	188	
	1250	4" size		5	3.200		121	86.50		207.50	265	
	1260	5" size	Q-2	5	4.800		175	135		310	400	
	1270	6" size		5	4.800		197	135		332	425	
	1280	8" size		4.50	5.333		281	150		431	540	
	1290	10" size		4	6		390	168		558	690	
	1300	12" size		3	8		595	224		819	1,000	
	1320	For gear actuator, add					60%					
	1400	Diverter, 150 lb. flanged, bronze or iron plugs										
	1440	2" pipe size	Q-1	2	8	Ea.	2,475	216		2,691	3,050	
	1450	3" pipe size	"	1.50	10.667	"	3,550	289		3,839	4,350	
	1650	Gate, 125 lb., N.R.S.,										
	2150	Flanged										
	2200	2" size	1 Plum	5	1.600	Ea.	252	48		300	350	
	2240	2-1/2" size	Q-1	5	3.200		258	86.50		344.50	415	
	2260	3" size		4.50	3.556		290	96		386	465	
	2280	4" size		3	5.333		415	144		559	675	
	2290	5" size	Q-2	3.40	7.059		705	198		903	1,075	
	2300	6" size		3	8		705	224		929	1,125	
	2320	8" size		2.50	9.600		1,225	269		1,494	1,750	
	2340	10" size		2.20	10.909		2,150	305		2,455	2,850	
	2360	12" size		1.70	14.118		2,950	395		3,345	3,850	
	2370	14" size		1.30	18.462		3,575	520		4,095	4,725	
	2380	16" size		1	24		5,225	675		5,900	6,775	
	2420	For 250 lb., flanged, add					200%	10%				
	3550	OS&Y, flanged										
	3600	2" size	1 Plum	5	1.600	Ea.	128	48		176	215	
	3640	2-1/2" size	Q-1	5	3.200		132	86.50		218.50	277	
	3660	3" size		4.50	3.556		149	96		245	310	
	3670	3-1/2" size		3	5.333		212	144		356	455	
	3680	4" size		3	5.333		212	144		356	455	
	3690	5" size	Q-2	3.40	7.059		350	198		548	690	
	3700	6" size		3	8		350	224		574	730	
	3720	8" size		2.50	9.600		625	269		894	1,100	
	3740	10" size		2.20	10.909		1,150	305		1,455	1,750	
	3760	12" size		1.70	14.118		1,525	395		1,920	2,275	
	3770	14" size		1.30	18.462		2,950	520		3,470	4,050	
	3780	16" size		1	24		4,575	675		5,250	6,050	
	3790	18" size		.80	30		6,125	840		6,965	8,050	
	3800	20" size		.60	40		8,550	1,125		9,675	11,100	
	3830	24" size		.50	48		12,700	1,350		14,050	16,100	
	3900	For 250 lb flanged, add					200%	10%				
	4350	Globe, OS&Y,										
	4540	Class 125, flanged										
	4550	2" size	1 Plum	5	1.600	Ea.	266	48		314	365	
	4560	2-1/2" size	Q-1	5	3.200		281	86.50		367.50	440	

MECHANICAL 15

A.3.7-10

ECO NUMBER 8

REPAIR UNDERGROUND HTW DISTRIBUTION SYSTEM LEAKS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-08
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-8 REPAIR LEAKS IN UNDERGROUND HTW PIPING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 04-16-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 127866.		
B. SIOH	$ 0.		
C. DESIGN COST	$ 0.		
D. TOTAL COST (1A+1B+1C)	$ 127866.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 127866.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	4.	$ 59.	15.08	$ 897.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	3319.	$ 4448.	14.88	$ 66184.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		3324.	$ 4507.		$ 67081.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 485.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7217.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 7217.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 4992.

5. SIMPLE PAYBACK PERIOD (1G/4) 25.61 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 74298.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .58
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT	FORT STEWART REPAIR LEAKS IN HTW PIPING	AEP NO	694 1331 002
		SHEET	OF
DESIGNER	W. TODD	DATE	4/11/96
CHECKER		DATE	

ECO - 8

The survey of valve pits indicated 28 sections of HTW piping with possible underground leaks. Based on the observed flow from the conduit vents, there are no large leaks in the system.

The leak locating tests were inconclusive. The background noise (flow, boiling, water hammer, etc.) was to great and the leaks are too small to obtain a good correlation. Shutting down the CEP and/or various HTW zones was discussed with the DPW staff, and it was decided that it was not a good idea to shut off the hospital and dining facilities to try and locate about 2 GPM of leaks.

ASSUMPTIONS

1) There is one small leak in each of the 28 sections of pipe identified during the survey.

2) The total flow of HTW from all of the leaks combined is about 1.66 gallons per minute.

3) All of the leaks can be found and repaired with three dig and cut operations per leak.

Note: Assumptions 1 and 3 are conservative estimates and can not be verified prior to the actual construction.

Energy and Cost Savings were calculated using a spreadsheet computer program. The calculations and results are shown on the following sheet.

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Existing Leaks in HTW Piping	Date:	04/15/96
ECO Number:	8		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x temperature difference

872496 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 2257.1 MBtu/Yr

Heating Fuel Use = 2257.1 MBtu/yr / 0.68 = 3319.3 MBtu/Yr

Heating Fuel Cost = 3319.3 MBtu/yr x $1.34 /MBtu = $4,448 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{1.66 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.175 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.175 BHP / 0.90 x 0.746 kW/HP = 0.145 kW

Electricity Use = 0.145 kW x 8760 Hr/Yr = 1268 kWh/Yr

Electricity Use = 1268 kWh/Yr x 0.003413 MBtu/kWh = 4.33 MBtu/Yr

Electricity Cost = 1268 kWh/Yr x $0.0469 /kWh = $59 /Year

Water Cost:

872496 Gal/Yr x $0.5562 /kGal = $485 /Year

Total Utility Cost:

Heating Fuel Cost	$4,448	/Year
Pumping (Elec) Cost	$59	/Year
Water Cost	$485	/Year
Total Utility Cost	$4,992	/Year

RS&H

SUBJECT FORT STEWART
REPAIR HTW PIPING LEAKS
DESIGNER W. TODD
CHECKER

AEP NO 694-1331-002
SHEET ___ OF ___
DATE 4/11/96
DATE

Valve Pit No.	No. of Conduit Vents w/Steam Flow
VP-1-4	2
VP-1-10	1
DP-1-13	1
VP-1-13	1
VP-1-14	1
VP-1-16	1
VP-1-17	1
DP-1-17/18	1
VP-1-18	1
VP-2N-1	1
VP-3-2	1
VP-3-2A	1
VP-3-3	1
VP-3-7	2
VP-3-9	2
VP-3-10	2
VP-3-11	3
VP-3-12	1
VP-3-13A	1
VP-3-14	2
VP-S-12	1
Total	28

CONSTRUCTION COST ESTIMATE

Project:	Repair HTW Piping Leaks	RS&H No.:	694-1331-002
Location:	Fort Stewart, GA	Date:	04/16/96
Basis:	Schematic Design	Estimator:	W.T.Todd
ECO Number: 8		Filename:	EST-8A.WB2

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total	COST	Material	Labor
Shut off HTW zone	4	MH	0	0	30.30	121	121		MMp475
Excavation, backhoe to 6'	90	CY	1.43	129	1.82	164	293	MMp28	MMp28
Excavation, by hand to 6'	60	CY	0	0	29.65	1779	1,779	MMp28	MMp28
Remove conduit, torch	18	LF	1.06	19	4.95	89	108	MMp22	MMp22
Remove pipe insulation	6	LF	0	0	4.84	29	29		MMp236
Valve off and drain pipe	0.50	MH	0	0	30.30	15	15		MMp475
Repair HTW leak - Weld	1	Ea	1.95	2	16.05	16	18	MMp144	MMp144
Open valves - fill pipe	0.50	Ea	0	0	30.30	15	15		MMp475
Replace pipe insulation	6	LF	0	0	4.84	29	29		MMp236
Weld conduit, 24" Sch 40	3	Ea	35	105	289	867	972	MMp144	MMp144
Backfill trench, by hand	60	CY		0	12.85	771	771	MMp28	MMp28
Compact backfill, by hand	60	CY		0	4.66	280	280	MMp28	MMp28
Backfill trench, dozer	90	CY	0.95	86	0.32	29	115	MMp28	MMp28
Compact backfill, dozer	90	CY	1.37	123	0.41	37	160	MMp28	MMp28
Total Cost per Leak				464		4241	4,705		
Total Cost for All Leaks	28	Ea	464	12992	4241	118748	131,740		
Subtotal Bare Costs				12992		118748	$131,740		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				12992		118748	131,740		
City Cost Index (Sav. GA)			0%	0	-44%	-52487	(52,487)	MMp533	MMp533
Subtotal				12992		66261	79,253		
OH & Profit Markups			10%	1299	53%	35118	36,417	MMp7	MMp475
Subtotal				14291		101379	115,670		
Sales Taxes			4.0%	572		NA	572	MMp476	
Subtotal				14863		101379	116,242		
Contingency			10%	1486	10%	10138	11,624	MEp6	MEp6
Total Construction Cost				16349		111517	127,866		
Design Fee				NA	0.0%	0	0		
SIOH				NA	0.0%	0	0		
Total Project Cost				16349		111517	$127,866		

LEGEND:

MEp### 1996 Means Electrical Cost Data, page ###.

MMp### 1996 Means Mechanical Cost Data, page ###.

RS&H

Telephone Call Confirmation

Project Number 694 1331 002

Local ______ L.D. ______ Placed B. Todd Rec'd ______ Date 4/11/96

Conversed with Gene Smith Of Fort Stewart DPW (912) 767-2138

Regarding Leak Repair of HTW Piping

Current leak repair method:

- Make an educated guess at where to start digging based on flow from valve pits and dig up trench.
- Remove (with cutting torch) a piece of conduit and look for leak. If not there, check direction of water flow in conduit and make another guess as to where to dig. Reweld conduit.
- Repeat above steps until leak is found. The leak is typically only about 1/4" in diameter and they can weld it shut.

Distribution:

Installing Contractor's Overhead & Profit

Below are the **average** installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

Column A: Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

Column B: Workers' Compensation rates are the national average of state rates established for each trade.

Column C: Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

Columns D and E: Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

Column F: Column F lists the total of Columns B, C, D, and E.

Column G: Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

Column H: Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

Column I: Column I is Column H multiplied by eight hours.

		A		B	C	D	E	F	G	H	I
		Base Rate Incl. Fringes		Workers' Comp. Ins.	Average Fixed Overhead	Overhead	Profit	Total Overhead & Profit		Rate with O & P	
Abbr.	Trade	Hourly	Daily					%	Amount	Hourly	Daily
Skwk	Skilled Workers Average (35 trades)	$25.95	$207.60	20.2%	16.8%	13.0%	10%	60.0%	$15.55	$41.50	$332.00
	Helpers Average (5 trades)	19.25	154.00	21.4		11.0		59.2	11.40	30.65	245.20
	Foreman Average, Inside ($.50 over trade)	26.45	211.60	20.2		13.0		60.0	15.85	42.30	338.40
	Foreman Average, Outside ($2.00 over trade)	27.95	223.60	20.2		13.0		60.0	16.75	44.70	357.60
Clab	Common Building Laborers	19.80	158.40	21.9		11.0		59.7	11.80	31.60	252.80
Asbe	Asbestos Workers	28.55	228.40	19.7		16.0		62.5	17.85	46.40	371.20
Boil	Boilermakers	30.05	240.40	17.7		16.0		60.5	18.20	48.25	386.00
Bric	Bricklayers	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Brhe	Bricklayer Helpers	20.00	160.00	19.4		11.0		57.2	11.45	31.45	251.60
Carp	Carpenters	25.20	201.60	21.9		11.0		59.7	15.05	40.25	322.00
Cefi	Cement Finishers	24.35	194.80	12.8		11.0		50.6	12.30	36.65	293.20
Elec	Electricians	29.30	234.40	8.0		16.0		50.8	14.90	44.20	353.60
Elev	Elevator Constructors	30.05	240.40	9.6		16.0		52.4	15.75	45.80	366.40
Eqhv	Equipment Operators, Crane or Shovel	26.75	214.00	12.9		14.0		53.7	14.35	41.10	328.80
Eqmd	Equipment Operators, Medium Equipment	25.70	205.60	12.9		14.0		53.7	13.80	39.50	316.00
Eqlt	Equipment Operators, Light Equipment	24.70	197.60	12.9		14.0		53.7	13.25	37.95	303.60
Eqol	Equipment Operators, Oilers	21.90	175.20	12.9		14.0		53.7	11.75	33.65	269.20
Eqmm	Equipment Operators, Master Mechanics	27.55	220.40	12.9		14.0		53.7	14.80	42.35	338.80
Glaz	Glaziers	24.90	199.20	16.0		11.0		53.8	13.40	38.30	306.40
Lath	Lathers	24.95	199.60	13.5		11.0		51.3	12.80	37.75	302.00
Marb	Marble Setters	25.65	205.20	19.4		11.0		57.2	14.65	40.30	322.40
Mill	Millwrights	26.55	212.40	13.2		11.0		51.0	13.55	40.10	320.80
Mstz	Mosaic & Terrazzo Workers	25.25	202.00	11.0		11.0		48.8	12.30	37.55	300.40
Pord	Painters, Ordinary	22.95	183.60	16.8		11.0		54.6	12.55	35.50	284.00
Psst	Painters, Structural Steel	23.95	191.60	62.5		11.0		100.3	24.00	47.95	383.60
Pape	Paper Hangers	23.30	186.40	16.8		11.0		54.6	12.70	36.00	288.00
Pile	Pile Drivers	25.35	202.80	33.6		16.0		76.4	19.35	44.70	357.60
Plas	Plasterers	24.20	193.60	17.4		11.0		55.2	13.35	37.55	300.40
Plah	Plasterer Helpers	20.15	161.20	17.4		11.0		55.2	11.10	31.25	250.00
Plum	Plumbers	30.05	240.40	10.2		16.0		53.0	15.95	46.00	368.00
Rodm	Rodmen (Reinforcing)	27.75	222.00	36.3		14.0		77.1	21.40	49.15	393.20
Rofc	Roofers, Composition	22.55	180.40	37.4		11.0		75.2	16.95	39.50	316.00
Rots	Roofers, Tile & Slate	22.60	180.80	37.4		11.0		75.2	17.00	39.60	316.80
Rohe	Roofers, Helpers (Composition)	15.95	127.60	37.4		11.0		75.2	12.00	27.95	223.60
Shee	Sheet Metal Workers	28.95	231.60	13.8		16.0		56.6	16.40	45.35	362.80
Spri	Sprinkler Installers	31.30	250.40	10.4		16.0		53.2	16.65	47.95	383.60
Stpi	Steamfitters or Pipefitters	30.30	242.40	10.2		16.0		53.0	16.05	46.35	370.80
Ston	Stone Masons	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Sswk	Structural Steel Workers	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Tilf	Tile Layers	25.05	200.40	11.0		11.0		48.8	12.20	37.25	298.00
Tilh	Tile Layers Helpers	20.30	162.40	11.0		11.0		48.8	9.90	30.20	241.60
Trlt	Truck Drivers, Light	20.35	162.80	17.0		11.0		54.8	11.15	31.50	252.00
Trhv	Truck Drivers, Heavy	20.70	165.60	17.0		11.0		54.8	11.35	32.05	256.40
Sswl	Welders, Structural Steel	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Wrck	*Wrecking	19.80	158.40	44.8		11.0		82.6	16.35	36.15	289.20

*Not included in Averages.

City Cost Indexes

	DIVISION	FLORIDA																	
		MIAMI			ORLANDO			PANAMA CITY			PENSACOLA			ST. PETERSBURG			TALLAHASSEE		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.3	72.8	81.5	125.3	85.9	95.0	141.6	83.4	96.9	138.9	85.9	98.1	126.2	85.6	95.0	125.7	85.2	94.6
031	CONCRETE FORMWORK	94.2	71.0	74.5	97.3	71.6	75.5	95.8	37.8	46.6	84.5	69.7	72.0	94.1	64.8	69.3	97.3	53.0	59.7
032	CONCRETE REINFORCEMENT	95.1	72.5	82.4	95.1	79.0	86.0	99.3	64.5	79.7	101.5	64.9	81.0	98.5	74.3	84.9	95.1	65.2	78.3
033	CAST IN PLACE CONCRETE	91.5	75.4	84.6	88.7	78.0	84.1	95.2	43.0	72.9	95.2	69.0	84.0	101.4	70.2	88.1	91.7	58.4	77.5
3	CONCRETE	87.4	74.3	80.8	86.3	76.7	81.4	95.0	46.6	70.5	93.5	70.1	81.7	92.6	70.1	81.2	87.7	59.2	73.3
4	MASONRY	76.9	70.2	72.8	77.4	75.6	76.2	84.9	37.4	55.4	82.6	67.6	73.3	119.2	66.9	86.7	83.6	52.6	64.4
5	METALS	98.8	93.5	96.8	107.9	95.0	103.0	97.2	75.1	88.9	97.1	89.6	94.3	101.0	92.4	97.7	99.2	88.1	95.0
6	WOOD & PLASTICS	88.6	72.7	80.6	94.5	71.1	82.8	92.9	38.3	65.6	80.1	71.1	75.6	90.8	65.2	78.0	94.5	51.6	73.0
7	THERMAL & MOISTURE PROTECTION	99.6	74.6	88.0	96.6	75.6	86.9	96.9	38.3	69.9	96.6	66.9	82.9	96.3	63.1	81.0	96.6	58.8	79.1
8	DOORS & WINDOWS	95.9	69.5	89.5	98.1	68.2	90.9	95.7	35.2	81.2	95.7	66.5	88.7	96.8	60.4	88.0	98.1	53.9	87.4
092	LATH, PLASTER & GYPSUM BOARD	101.0	72.5	82.5	101.6	70.8	81.7	99.7	36.9	59.0	94.5	70.9	79.2	98.9	64.8	76.8	101.6	50.7	68.6
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	72.5	83.0	102.4	70.8	82.0	96.6	36.9	58.0	96.6	70.9	79.9	98.0	64.8	76.5	102.4	50.7	68.9
096	FLOORING & CARPET	121.8	75.3	110.7	113.0	74.9	103.8	112.3	24.6	91.3	106.7	68.0	97.4	111.4	67.8	100.9	113.0	49.7	97.8
099	PAINTING & WALL COVERINGS	100.9	70.1	83.0	104.2	77.6	88.7	104.2	34.5	63.7	104.2	78.5	89.3	104.2	65.4	81.6	104.2	55.7	76.0
9	FINISHES	108.6	71.4	89.7	107.7	72.7	89.9	107.2	34.4	70.2	104.5	70.5	87.2	106.0	65.3	85.3	107.7	51.9	79.3
10-14	TOTAL DIV. 10-14	100.0	81.8	96.1	100.0	83.9	96.6	100.0	65.4	92.6	100.0	73.3	94.3	100.0	76.8	95.1	100.0	74.0	94.5
15	MECHANICAL	100.0	72.9	88.0	100.0	70.8	87.1	100.0	34.6	71.1	100.0	68.8	86.2	100.0	68.7	86.2	100.0	54.8	80.0
16	ELECTRICAL	98.0	84.9	89.3	98.0	63.0	74.6	96.3	47.1	63.5	101.8	63.4	76.2	98.5	68.1	78.2	98.0	58.3	71.5
1-16	WEIGHTED AVERAGE	97.5	76.7	87.4	99.2	75.1	87.6	99.2	48.1	74.5	98.8	71.8	85.7	101.0	71.8	86.9	98.5	62.1	80.9

	DIVISION	FLORIDA			GEORGIA														
		TAMPA			ALBANY			ATLANTA			AUGUSTA			COLUMBUS			MACON		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	126.9	85.6	95.1	110.4	74.2	82.5	114.3	92.8	97.8	110.2	91.5	95.8	110.4	74.3	82.6	111.6	91.9	96.5
031	CONCRETE FORMWORK	97.3	64.9	69.8	96.9	50.8	57.8	98.0	70.3	74.5	94.5	61.8	66.7	96.9	50.4	57.4	95.9	65.9	70.5
032	CONCRETE REINFORCEMENT	95.1	74.3	83.4	95.1	76.4	84.6	98.5	77.5	86.7	104.0	69.1	84.4	95.1	76.4	84.6	97.4	76.7	85.8
033	CAST IN PLACE CONCRETE	101.7	70.2	88.2	95.5	48.9	75.6	101.1	71.2	88.3	95.6	57.9	79.5	95.5	49.5	75.8	95.5	53.3	77.5
3	CONCRETE	92.4	70.2	81.2	89.4	57.0	73.0	94.0	72.1	82.9	90.5	62.2	76.2	89.4	57.0	73.0	89.7	65.1	77.3
4	MASONRY	82.8	66.9	72.9	83.4	38.9	55.7	92.1	63.6	74.4	92.2	49.1	65.4	83.4	39.3	56.0	98.6	46.7	66.4
[illegible]	METALS	102.2	92.4	98.5	96.8	89.0	93.9	93.7	74.5	86.4	92.4	69.4	83.7	96.7	89.3	93.9	91.7	90.1	91.1
[illegible]	WOOD & PLASTICS	94.5	65.2	79.8	93.7	51.6	72.6	99.7	72.2	86.0	95.9	64.6	80.3	93.7	51.3	72.5	97.4	69.9	83.6
7	THERMAL & MOISTURE PROTECTION	96.6	64.3	81.7	96.4	55.7	77.6	94.2	70.0	83.0	93.6	59.5	77.9	96.1	55.7	77.5	95.1	62.9	80.2
8	DOORS & WINDOWS	98.1	60.4	89.0	95.9	53.7	85.7	94.2	67.9	87.9	90.6	59.3	83.1	95.9	53.8	85.7	94.2	64.8	87.1
092	LATH, PLASTER & GYPSUM BOARD	101.6	64.8	77.7	101.6	50.7	68.6	112.5	72.0	86.2	111.3	64.1	80.7	101.6	50.4	68.4	108.3	69.5	83.2
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	64.8	78.1	102.4	50.7	69.0	108.7	72.0	84.9	108.7	64.1	79.8	102.4	50.4	68.7	95.9	69.5	78.8
096	FLOORING & CARPET	113.0	67.8	102.1	113.0	40.4	95.6	87.8	75.0	84.8	86.7	51.5	78.2	113.0	41.0	95.7	87.8	47.5	78.2
099	PAINTING & WALL COVERINGS	104.2	65.4	81.6	100.9	50.4	71.5	99.0	72.1	83.4	99.0	47.9	69.3	100.9	48.3	70.3	102.4	59.0	77.2
9	FINISHES	107.7	65.3	86.1	105.8	48.1	76.4	95.1	71.5	83.1	94.4	58.6	76.1	105.7	47.8	76.2	91.5	62.0	76.5
10-14	TOTAL DIV. 10-14	100.0	76.8	95.1	100.0	69.5	93.5	100.0	75.4	94.8	100.0	71.0	93.8	100.0	69.4	93.5	100.0	73.6	94.4
15	MECHANICAL	100.0	68.7	86.2	100.0	56.8	80.9	100.1	71.7	87.5	100.1	54.0	79.7	100.0	46.2	76.2	100.0	52.1	78.8
16	ELECTRICAL	97.5	68.1	77.9	93.3	68.1	76.5	93.4	82.3	86.0	96.9	61.3	73.2	93.3	49.4	64.0	91.4	63.3	72.7
1-16	WEIGHTED AVERAGE	99.5	71.8	86.1	97.1	60.8	79.5	96.5	75.0	86.1	95.5	62.5	79.5	97.1	55.7	77.1	95.4	65.4	80.9

	DIVISION	GEORGIA						HAWAII			IDAHO								
		SAVANNAH			VALDOSTA			HONOLULU			BOISE			LEWISTON			POCATELLO		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.6	76.1	84.0	122.0	74.5	85.5	115.0	112.0	112.7	86.4	99.3	96.3	90.4	92.7	92.2	89.1	99.3	96.9
031	CONCRETE FORMWORK	97.0	60.5	66.0	80.8	51.9	56.3	102.1	158.7	150.1	97.4	89.3	90.5	106.3	87.1	90.0	97.4	89.3	90.5
032	CONCRETE REINFORCEMENT	100.7	69.5	83.2	100.8	50.3	72.5	109.9	125.0	118.4	96.0	78.4	86.1	108.6	96.1	101.6	96.3	78.5	86.3
033	CAST IN PLACE CONCRETE	91.5	56.6	76.6	93.0	57.4	77.8	170.2	127.7	152.0	98.6	93.8	96.6	107.8	93.9	101.8	99.6	93.8	97.1
3	CONCRETE	88.3	62.5	75.3	92.8	55.5	74.0	153.0	139.4	146.1	103.2	88.7	95.9	115.5	91.0	103.1	103.7	88.6	96.1
4	MASONRY	86.9	57.6	68.7	89.8	50.6	65.4	131.3	134.3	133.2	131.8	81.0	100.2	128.8	96.6	108.8	136.3	82.7	103.0
5	METALS	97.1	87.6	93.5	96.5	80.7	90.6	117.4	107.6	113.7	112.9	82.2	101.3	96.2	90.7	94.1	112.5	82.2	101.1
6	WOOD & PLASTICS	93.8	60.9	77.3	76.0	50.3	63.1	100.6	165.6	133.1	95.1	88.5	91.8	98.7	83.6	91.2	95.1	88.5	91.8
7	THERMAL & MOISTURE PROTECTION	96.4	59.2	79.3	96.1	60.0	79.5	109.5	133.7	120.6	97.9	84.0	91.5	167.6	89.8	131.7	98.0	83.8	91.5
8	DOORS & WINDOWS	95.9	56.7	86.4	91.4	46.3	80.5	110.6	146.5	119.2	94.9	81.7	91.7	116.3	85.0	108.7	94.9	78.5	91.0
092	LATH, PLASTER & GYPSUM BOARD	101.6	60.4	74.9	93.7	49.4	65.0	95.7	167.7	142.3	89.0	87.9	88.3	135.3	83.0	101.4	89.0	87.9	88.3
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	60.4	75.2	98.0	49.4	66.5	132.8	167.7	155.4	96.2	87.9	90.8	144.9	83.0	104.8	96.2	87.9	90.8
096	FLOORING & CARPET	113.0	60.7	100.4	105.1	48.5	91.5	127.8	128.3	127.9	97.5	74.8	92.1	135.1	97.9	126.2	97.5	74.8	92.1
[illegible]	PAINTING & WALL COVERINGS	100.9	59.9	77.0	100.9	43.7	67.6	123.8	148.0	137.9	109.4	67.9	85.2	134.4	91.3	109.3	109.4	78.2	91.3
[illegible]	FINISHES	105.8	60.5	82.8	101.9	50.0	75.5	124.5	153.9	139.5	93.2	84.6	88.8	156.4	89.0	122.1	93.2	85.8	89.4
10-14	TOTAL DIV. 10-14	100.0	71.7	94.0	100.0	70.1	93.7	100.0	129.2	106.2	100.0	86.1	97.0	100.0	100.6	100.1	100.0	86.1	97.0
15	MECHANICAL	100.0	55.8	80.5	100.0	48.7	77.3	100.1	119.4	108.6	99.8	85.6	93.5	100.6	94.1	97.7	99.8	85.6	93.5
16	ELECTRICAL	93.3	65.4	74.7	90.2	40.8	57.2	109.7	128.8	122.5	85.2	78.7	80.9	87.5	92.2	90.6	85.7	79.4	81.5
1-16	WEIGHTED AVERAGE	97.2	64.6	81.4	96.8	55.0	76.6	115.9	129.5	122.5	101.0	85.2	93.4	111.9	92.1	102.3	101.3	85.5	93.7

A.3.8-9

COST INDEXES

W/ LEAK LOCATOR

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-08
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-8 REPAIR LEAKS IN UNDERGROUND HTW PIPING
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 04-16-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 53511.		
B. SIOH	$ 3211.		
C. DESIGN COST	$ 3211.		
D. TOTAL COST (1A+1B+1C)	$ 59933.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 59933.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	4.	$ 59.	15.08	$ 897.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	3319.	$ 4448.	14.88	$ 66184.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		3324.	$ 4507.		$ 67081.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 485.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 7217.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 7217.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 4992.

5. SIMPLE PAYBACK PERIOD (1G/4) 12.00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 74298.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.24
(IF < 1 PROJECT DOES NOT QUALIFY)

W/LEAK LOCATOR

CONSTRUCTION COST ESTIMATE

Project:	Repair HTW Piping Leaks	RS&H No.:	694-1331-002
Location:	Fort Stewart, GA	Date:	04/15/96
Basis:	Schematic Design	Estimator:	W.T.Todd
ECO Number: 8		Filename:	EST-8.WB2

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total	COST	Material	Labor
Shut off HTW zone	4	MH	0	0	30.30	121	121		MMp475
Perform leak locator test	1	Ea	0	0	300	300	300		Vendor
Excavation, backhoe to 6'	30	CY	1.43	43	1.82	55	98	MMp28	MMp28
Excavation, by hand to 6'	20	CY	0	0	29.65	593	593	MMp28	MMp28
Remove conduit, torch	6	LF	1.06	6	4.95	30	36	MMp22	MMp22
Remove pipe insulation	2	LF	0	0	4.84	10	10		MMp236
Valve off and drain pipe	0.50	MH	0	0	30.30	15	15		MMp475
Repair HTW leak - Weld	1	Ea	1.95	2	16.05	16	18	MMp144	MMp144
Open valves - fill pipe	0.50	Ea	0	0	30.30	15	15		MMp475
Replace pipe insulation	2	LF	0	0	4.84	10	10		MMp236
Weld conduit, 24" Sch 40	1	Ea	35	35	289	289	324	MMp144	MMp144
Backfill trench, by hand	20	CY		0	12.85	257	257	MMp28	MMp28
Compact backfill, by hand	20	CY		0	4.66	93	93	MMp28	MMp28
Backfill trench, dozer	30	CY	0.95	29	0.32	10	39	MMp28	MMp28
Compact backfill, dozer	30	CY	1.37	41	0.41	12	53	MMp28	MMp28
Total Cost per Leak				156		1826	1,982		
Total Cost for All Leaks	28	Ea	156	4368	1826	51128	55,496		
Subtotal Bare Costs				4368		51128	$55,496		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				4368		51128	55,496		
City Cost Index (Sav. GA)			0%	0	-44%	-22599	(22,599)	MMp533	MMp533
Subtotal				4368		28529	32,897		
OH & Profit Markups			10%	437	53%	15120	15,557	MMp7	MMp475
Subtotal				4805		43649	48,454		
Sales Taxes			4.0%	192		NA	192	MMp476	
Subtotal				4997		43649	48,646		
Contingency			10%	500	10%	4365	4,865	MEp6	MEp6
Total Construction Cost				5497		48014	53,511		
Design Fee				NA	6.0%	3211	3,211		
SIOH				NA	6.0%	3211	3,211		
Total Project Cost				5497		54436	$59,933		

LEGEND:

MEp### 1996 Means Electrical Cost Data, page ###.
MMp### 1996 Means Mechanical Cost Data, page ###.

ECO NUMBER 9

REDUCE OR ELIMINATE HTW DISCHARGE DURING SEP START-UP

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-9
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 0.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 0.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 0.

****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 4.	15.08	$ 62.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	111.	$ 149.	14.88	$ 2213.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		111.	$ 153.		$ 2275.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1067.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 15877.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 15877.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1220.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 18152.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

WITH ECO'S 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-9
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 28652.		
B. SIOH	$ 1720.		
C. DESIGN COST	$ 1720.		
D. TOTAL COST (1A+1B+1C)	$ 32092.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 32092.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	111.	$ 149.	14.88	$ 2213.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		111.	$ 149.		$ 2213.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 9032.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 134396.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 134396.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 9181.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.50 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 136609.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.26
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-09X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 0.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 0.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 0.
****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 4.	15.08	$ 62.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	96.	$ 129.	14.88	$ 1914.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		96.	$ 133.		$ 1976.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1067.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 15877.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 15877.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1200.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 17853.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-09Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-9 REDUCE HTW LOSSES DURING SEP START-UP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 0.		
B. SIOH	$ 0.		
C. DESIGN COST	$ 0.		
D. TOTAL COST (1A+1B+1C)	$ 0.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 0.

****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 4.	15.08	$ 62.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	85.	$ 114.	14.88	$ 1695.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		85.	$ 118.		$ 1757.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1067.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 15877.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 15877.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 1185.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 17634.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H

SUBJECT: FORT STEWART
IMPROVE SEP START-UP
DESIGNER: W. TODD
CHECKER:

AEP NO: 694 1331 002
SHEET: OF
DATE: 2-1-96
DATE:

ECO-9 OPTION A

The SEP was started up from 13 Nov 95 - 23 Nov 95

The HTW system make-up water for those 11 days:

Actual HTW Make-up = 138,350 Gal.

Average HTW make-up for the previous 6 months:

$$\frac{(4.6 + 5.2 + 5.7 + 5.3 + 5.0 + 4.6)\,\text{GPM}}{6} = 5.067\ \text{GPM}$$

Average HTW Make-up $= 5.067\ \frac{\text{GAL}}{\text{min}} \times 1440\ \frac{\text{min}}{\text{day}} \times 11\ \text{days} = 80256$ Gal

Assuming the SEP start-up losses = Actual - Average:

SEP Startup losses = 138350 GAL - 80256 GAL = 58094 $\frac{\text{GAL}}{\text{YR}}$

O&M Cost (Assume start-up takes 4 hr/day & 10 days)

Current startup Costs $= 10\ \text{days} \times 8\ \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \$2069/\text{YR}$

Proposed startup costs $= 10\ \text{days} \times 4\ \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \$1034/\text{YR}$

O&M Savings $= \$2069 - \$1035 = \boxed{\$1035/\text{YR}}$

Proposed Operating Cost = \$13163 - \$1035 = \$12128/YR

RS&H

SUBJECT FORT STEWART

DESIGNER W. Todd

CHECKER

AEP NO 694 1331 002

SHEET ____ OF ____

DATE 2-1-96

DATE

ECO-9

Satellite Energy Plant, Operating Costs - Labor

Assumptions:

1) SEP operates for 4½ months / year
2) SEP startup takes 10 days / year
3) SEP shut down takes 3 days / yr
4) Normal operation requires one visit per shift that takes about 1 hour / visit.
5) Start-up and shut-down requires one operator Full time for one shift each day.

Pipefitters hourly rate w/ benefits = \$46.35 mmp 475

Adjusted for Savannah GA = \$46.35 × 0.558 = \$25.86 mmp 533

Labor Costs:

Startup: $10 \frac{\text{days}}{\text{yr}} \times 8 \frac{\text{hrs}}{\text{day}} \times \$25.86/\text{hr} = \$2069/\text{YR}$

Operation: $4.5 \frac{\text{mo}}{\text{YR}} \times 30 \frac{\text{day}}{\text{mo}} \times 3 \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \$10473/\text{YR}$

Shut down: $3 \frac{\text{day}}{\text{YR}} \times 8 \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \$621/\text{YR}$

Total Labor Cost = \$1034/YR + \$9310/YR + \$621/YR = \$13163/YR

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Improve SEP Start-up Procedure	Date:	02/12/96
ECO Number:	9		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x average temperature difference

58094 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 155 °F = 75.1 MBtu/Yr

Heating Fuel Use = 75.1 MBtu/yr / 0.68 = $\boxed{\text{110.5 MBtu/Yr}}$

Heating Fuel Cost = 110.5 MBtu/yr x $1.34 /MBtu = $148 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{3.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.39 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x Hr/Yr

Electric Demand = 0.39 BHP / 0.90 x 0.746 kW/HP = 0.32 kW

Electricity Use = 0.32 kW x 264 Hr/Yr = 84 kWh/Yr

Electricity Use = 84 kWh/Yr x 0.003413 MBtu/kWh = $\boxed{\text{0.3 MBtu/Yr}}$

Electricity Cost = 84 kWh/Yr x $0.0469 /kWh = $4 /Year

Water Cost:

58094 Gal/Yr x $0.5562 /kGal = $\boxed{\text{\$32 /Year}}$

Total Utility Cost:

Heating Fuel Cost	$148	/Year
Pumping (Elec) Cost	$4	/Year
Water Cost	$32	/Year
Total Utility Cost	$184	/Year

RS&H

SUBJECT FORT STEWART
SEP Condensate Return
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET ______ OF ______
DATE 2-5-96
DATE

ECO NO. 9 - OPTION B

INSTALL NEW "CONDENSATE" RETURN PUMP IN SEP.

PUMP VOLUME (1)

PUMP WILL MOVE WATER THROUGH EXISTING 4 IN CONDENSATE RETURN LINE FROM SEP TO CEP.
ASSUME 8 FT/SEC LINE VELOCITY

$$VOL.RATE = AREA \times VELOCITY = \frac{\pi D^2}{4} \times v$$
$$= 3.14/4 \times (4\ IN/12\ IN/FT)^2 \times 8\ ft/sec = 0.698\ cf/sec.$$

$$0.698\ cf/sec \times 8.34\ \#/cf \times 60\ sec/min = \boxed{349\ gpm.}$$

PUMP HEAD (1)

ACTUAL PIPE DISTANCE IS APPROXIMATELY 1 MILE WITH NO SIGNIFICANT ELEVATION CHANGE.
HEAD LOSS PER 100 FT PIPE = 6 ft/100 ft PIPE.

$$1\ mile \times 5280\ ft/mi \times \frac{6\ FT\ HEAD^*}{100\ FT\ PIPE} = \boxed{316\ FT.}$$

* ASHRAE FUNDAMENTALS HAND BOOK, CHAPTER 34, TABLE 1.

PUMP POWER (1)

$$HP = \frac{gpm \times TDH}{3960 \times \eta} = 349 \times 316 / 3960 / 0.7 = \boxed{40\ HP}$$

PUMP VOLUME (2)

ABOVE PUMP VOLUME IMPLIES A SEP STEAM CONSUMPTION OF 350 gpm × 500 PPH/gpm = 175000 #/HR WHICH IS 2 TIMES THE BOILER CAPACITY, AND IS THEREFORE TOO CONSERVATIVE.

A LESS CONSERVATIVE ESTIMATE WOULD BE BASED ON THE ASSUMPTION THAT THE EXISTING HEAT REQUIREMENT FOR THE TWO CASCADES IS APPROXIMATELY EQUAL TO 146,000 #/HR STEAM (1)

(1) SYSTEMS CORP REPORT, Pg A-1, FIG. A-1

RS&H SUBJECT	FORT STEWART SEP Condensate Return	AEP NO	694 1331 002
		SHEET	OF
DESIGNER	G. Fallon	DATE	2-5-96
CHECKER		DATE	

ECO-9B

Pump Volume (2) (Cont.)

$$146{,}000 \text{ \#/HR} / 500 \text{ PPH/gpm} = \boxed{292 \text{ gpm}}$$

Pump Power (2)

$$H.P. = \frac{gpm \times TDH}{3960 \times \eta} = \frac{292 \times 316}{3960 \times 0.7} = \boxed{33 \text{ H.P.}}$$

SEP SYSTEM HEAT LOSSES WITH NO HEATING LOAD.

TEST DATA SHOWED A 45F° TEMPERATURE LOSS OVER A 2 HOUR PERIOD WHEN THE AMBIENT TEMPERATURE WAS 60+°F (ASSUME NO HEAT LOAD)

ESTIMATED WATER IN SEP DISTRIBUTION PIPING IS 13,500gal
ESTIMATED WATER IN SEP INTERNAL PIPING IS 1000gal
CASCADE HEATER VOLUME @ NORMAL OPERATING LEVEL IS 2500 gal × 2 HEATERS = 5000 gal

TOTAL SEP CAPACITY = 13500 + 1000 + 5000 = 19500gal

$$\text{HEAT LOSS RATE} = \frac{\text{HEAT LOSS}}{\text{TIME}} = \frac{19500 gal \times 8.34 \text{ \#/gal} \times (45F^\circ)}{2 \text{ HRS}}$$

$$= 3.66 \text{ MBTU/HR}$$

SEP BUILDING LOSSES

BLDG 2" pipe = 52gpm
52gpm × 500 PPH/gpm × (375 − 100) = 7.15 MBTU/HR

BLDG 1½" pipe = 28gpm
28gpm × 500 PPH/gpm × (375 − 100) = 3.85 MBTU/HR

BLDG. 1¼ pipe = 18 gpm
18gpm × 500 PPH/gpm × (375 − 100) = 2.475 MBTU/HR

BLDG 1" pipe = 8.5 gpm
8.5 × 500 × (375 − 100) = 1.17 MBTU/HR

RS&H

SUBJECT FORT STEWART
SEP Condensate Return
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET ___ OF ___
DATE 2-5-96
DATE

ECO-9B

TOTAL MAX SEP LOAD

7.15 X 2 + 3.85 + 2.48 + 1.17 + 3.66 = $\boxed{25.46 \text{ MBTU/HR}}$

MAX ACTUAL PUMP FLOW

25.46 MBTU/HR / (1199-360) BTU/#s / 500 PPH/gpm X 1E6 = $\boxed{60.7 \text{ gpm}}$

ACTUAL PUMP POWER

$$H.P. = \frac{60.7 \text{ gpm} \times 316 \text{ ft}}{3960 \times 0.7} = \boxed{6.92 \text{ HP}} \quad \times .746 = \boxed{5.16 \text{ kw}}$$

ENERGY LOST (Assume actual losses are 50% less since water is cold at first)

138,350 Gallons - 80256 Gallons ≈ 58,100 gal (see ECO-9 calc.)

58,100 gal x 8.34 #/gal x (348.6 - (68-32)) BTU/# / 1E6 x .5 = 75.7 MBTU/YR

ENERGY LOSS VALUE (Assume 0.68 boiler eff.)

75.7 MBTU/yr ÷ 0.68 = $\boxed{111.4 \text{ MBtu/YR}}$ x $1.34 /mBtu = $\boxed{\$149/\text{YR}}$

WATER LOSS VALUE

58,100 gal x 0.5562 $/1000gal = $\boxed{\$32/\text{YR}}$

PUMPING COST (ASSUME RETURN PUMPING ENERGY IS THE SAME)

58,100 / (11 DAYS x 60 m/H x 24 H/D) = $\boxed{3.67 \text{ gpm}}$

$$HP = \frac{3.67 \text{ gpm} \times 310 \text{ ft}}{3960 \times 0.7} = \boxed{0.41 \text{ HP}} \quad \times .746 = \boxed{0.306 \text{ kw}}$$

0.306 KW x 11 DAY x 24 HR/DAY = $\boxed{81 \text{ kwh/YR}}$ = 0.3 MBtu/YR

4847 kwh x 0.0469 $/kwh = $\boxed{\$4/\text{YR}}$

RS&H

SUBJECT FORT STEWART | AEP NO 694 1331 002
SHEET ____ OF ____
DESIGNER G. FALLON | DATE 2-9-96
CHECKER ____ | DATE ____

ECO-9B

UTILITY COST SAVINGS

COST = ENERGY COST + WATER COST + PUMPING COST

= 149 + 32 + 4

$\boxed{= \$185}$

O & M COSTS:

SEP startup: $10 \text{ days} \times 2 \frac{\text{hours}}{\text{day}} \times \$25.86/\text{HR} = \$517/\text{YR}$

Operation: $4.5 \frac{\text{mo}}{\text{YR}} \times 30 \frac{\text{day}}{\text{mo}} \times 1 \frac{\text{hr}}{\text{day}} \times \$25.86/\text{HR} = \$3,491/\text{YR}$

Shut down: $3 \text{ days} \times 2 \frac{\text{hours}}{\text{day}} \times \$25.86/\text{HR} = \$155/\text{YR}$

Total Operating Costs = $4163/YR

ANNUAL SAVINGS

HEATING FUELS = $\boxed{111 \text{ MBtu/YR}}$ SAME AS OPTION A

ELECTRICITY = 0.3 - 0.3 = $\boxed{0 \text{ mBtu/YR}}$

WATER = $\boxed{\$32/\text{YR}}$

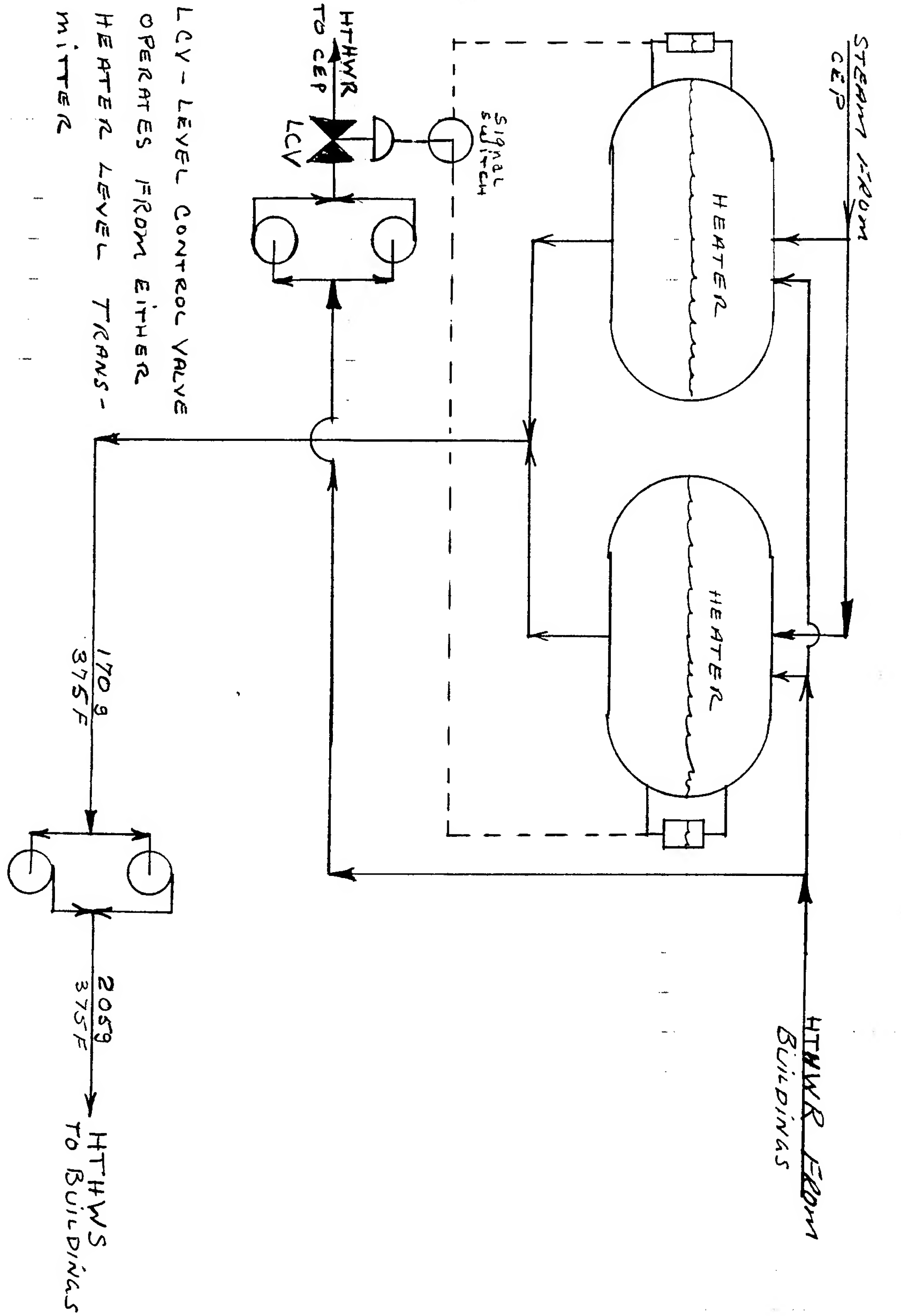
O & M = $13163 - $4163 = $\boxed{\$9000/\text{YR}}$

RS&H

SUBJECT: FORT STEWART
Pump for SEP to CEP
DESIGNER: G. Fallon
CHECKER:

AEP NO: 694 1331 002
SHEET: ___ OF ___
DATE: 2-9-96
DATE:

ECO-9B



1441
912-767-8931

CONSTRUCTION COST ESTIMATE

Project:	Install new Return Pump in the SEP	RS&H No.:	694-1331-002
Location:	Fort Stewart, GA	Date:	02/14/96
Basis:	Schematic Design	Estimator:	G. W. Fallon
ECO No.:	9B	Filename:	EST-9B.WB2

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Pump, 300 gpm, 310' hd	2	Ea	2325	4650	480	960	5,610	MMp202	MMp202
Iso. Valves, 4", 300 lb	4	Ea	1300	5200	155	620	5,820	MMp197	MMp197
Elbows, 4", Weld Joint	4	Ea	17.50	70	97.05	388	458	MMp158	MMp158
Flange, 4", 400 lb, W.N.	8	Ea	44.00	352	60.60	485	837	MMp165	MMp165
Pipe, 4", Sch. 80, W.E.	40	LF	16.05	642	14.70	588	1,230	MMp142	MMp142
Welding Labor/Joint	36	Ea	0	0	60.60	2182	2,182	MMp144	MMp144
Level Control Valve	1	Ea	5000	5000	2000	2000	7,000	Estimate	Estimate
Elec. Conn. 480V, 30 hp	2	Ea	1125	2250	1000	2000	4,250	MEp320	MEp320
Subtotal Bare Costs				18164		9223	$27,387		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				18164		9223	27,387		
City Cost Index (Sav. GA)			0%	0	-44%	-4077	(4,077)	MMp533	MMp533
Subtotal				18164		5146	23,310		
OH & Profit Markups			10%	1816	53%	2727	4,543	MMp7	MMp475
Subtotal				19980		7873	27,853		
Sales Taxes			4.0%	799		NA	799	MMp476	
Total Construction Cost				20779		7873	28,652		
Design Fee				NA	6.0%	1719	1,719		
SIOH				NA	6.0%	1719	1,719		
Subtotal				20779		11311	32,090		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				20779		11311	$32,090		

LEGEND:

MEp### 1996 Means Electrical Cost Data, page ###.

MMp### 1996 Means Mechanical Cost Data, page ###.

ECO-9A

1995 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	4020			2.8	
	2	5090			3.5	
	3	3730			2.6	
	4	7330			5.1	
	5	2280			1.6	
	6	7650			5.3	
	7	2440			1.7	
	8	3700			2.6	
	9	9110			6.3	
	10	10140			7.0	
	11	5410			3.8	
	12	6830			4.7	
	13	10080			7.0	
	14	9320			6.5	
NOV	15	12200		8708	8.5	6.0
	16	13450			9.3	
	17	16220			11.3	
	18	14560	Total=138,350		10.1	
	19	10130			7.0	
	20	13380			9.3	
	21	14530			10.1	
	22	14460			10.0	
	23	10020			7.0	
	24	7950			5.5	
	25	11720			8.1	
	26	4100			2.8	
	27	4450			3.1	
	28	10070			7.0	
	29	9450			6.6	
	30	7410	261230		5.1	
	1	7430			5.2	
	2	9300			6.5	
	3	10090			7.0	
	4	8930			6.2	
	5	9170			6.4	
	6	6500			4.5	
	7	9930			6.9	
	8	7770			5.4	
	9	7430			5.2	
	10	9410			6.5	
	11	9100			6.3	
	12	8010			5.6	
	13	9780			6.8	
	14	9470			6.6	
DEC	15	10930		8371	7.6	5.8
	16	8650			6.0	
	17	9770			6.8	
	18	8500			5.9	
	19	6790			4.7	
	20	7300			5.1	
	21	7620			5.3	
	22	4110			2.9	
	23	6220			4.3	
	24	7180			5.0	
	25	4420			3.1	
	26	5050			3.5	
	27	7010			4.9	
	28	9310			6.5	
	29	10690			7.4	
	30	11030			7.7	
	31	12610	259510		8.8	

A.3.9-15

ECO-9A

OPERATING INSTRUCTIONS

CASCADE WATER HEATER

I. DESCRIPTION

The Chicago Heater Company cascade hot water heater has been specifically designed to handle all of the system returns outlined in the contract specifications. In order to insure the most efficient use of steam pressure and energy level in the cycle and the lowest operating cost, these specified design rates of flow should not be exceeded.

The cascade heater is a direct contact heat exchanger, heating in such a machine is achieved by passing carefully controlled streams of water through a steam atmosphere.

II. OPERATION

System returns enter the cascade heater through the water inlet nozzle provided on the shell. These returns are conveyed upward through ducting within the unit to a distributor weir over which they cascade downward on to specially designed water distributing trays. These trays break up the water into thin streams to expose the greatest surface area to the steam which fills the heating section. In the steam space the water is heated to within 10° of the steam temperature. The hot water leaving the heating element falls into the storage compartment and is ready for service.

III. BEFORE START UP

This equipment should not be started until all operating personnel are familiar with the start up procedures herein outlined. Particular attention should be paid to the operation of the various controls furnished with the cascade heater.

Prior to admitting water and steam to the unit, the following equipment should be checked.

A. The atmospheric vent should be wide open. Note: At low starting loads it may be necessary to throttle this valve slightly to bring the unit up to pressure, but in no case is the valve to be fully closed.

B. The relief valve should be checked to be certain that gags and shipping stops have been removed.

C. Manually operate all controls. Control valves should be checked for correct travel, freedom from friction, and correct action to match their controlling instrument. For successful operation, the actuator stem and valve plug stem must move freely in response to loading pressure changes on the diaphragm.

D. Alarm switches should be checked to be certain that the switches are installed for proper function and alarm devices are operational.

E. Thermometer, pressure gauges, and all recording instruments should be properly calibrated.

IV. START UP

The following procedures should be followed when commencing operation of the cascade heater after all equipment has been tested and checked.

1. Flush out all lines and tanks with water until there is no apparent indication of foreign matter or rust.

2. Close outlet valve from heater to feed pumps.

3. Start flow of inlet water and slowly increase from 50 to 60 per cent of design rate.

4. Open valve admitting steam into tank slowly. Possibly some rumbling may occur but this may be disregarded with the cold tank. Check steam gauge in the heater and make absolutely certain that positive steam pressure is maintained in the heater; if steam supply is insufficient, utilize other sources such as live steam through a reducing valve or any other auxiliary steam supply.

5. Filling the vessel with water will purge most of the air from the tank. As the water approaches operating level, increase the steam flow. Caution: Filling the tank with steam and then flooding with cold water subjects the tank to undue stresses caused by vacuum created by rapid condensation. Never fill the vessel with steam and admit cold water.

6. As the water reaches the operating level, check the operation of inlet controllers. Make adjustments at all controllers. Manually continue the flow of water until high level controls operate. Check operating level of controllers and alarms at this point.

7. When a considerable volume of steam is issuing from the vent valve, commence throttling back vent valve until only a plume of vapor can be seen issuing from it. At this point the water temperature within the unit whould be within 10° of saturation temperature of steam at heater pressure. A lower water temperature indicates that pockets of air have left and completely purged. If this occurs, open steam valve wide, then open vent valve wide for a few seconds, then throttle back to force pockets to the vent.

8. Open steam valve wide.

9. The unit is now ready for service and the outlet valve may be opened and admit water to the feed pumps. When the unit is operating correctly, the storage water temperature should be within 10° of the saturated temperature of the steam at heater pressure.

10. For any special equipment that has been supplied with this unit, check the descriptive literature and operating instructions for that equipment.

R010-070 Contractor's Overhead & Profit

Below are the average installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

Column A: Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

Column B: Workers' Compensation rates are the national average of state rates established for each trade.

Column C: Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

Columns D and E: Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with sma annual billing. The overhead percentages for any given contract vary greatly and depend on a number of factors, such as the co annual volume, engineering and logistical support costs, and st requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevaili economic conditions. All factors should be examined very carefi each job.

Column F: Column F lists the total of Columns B, C, D, and E.

Column G: Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

Column H: Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

Column I: Column I is Column H multiplied by eight hours.

		A		B	C	D	E	F	G	H	I
		Base Rate Incl. Fringes		Workers' Comp. Ins.	Average Fixed Overhead	Overhead	Profit	Total Overhead & Profit		Rate with O & P	
Abbr.	Trade	Hourly	Daily					%	Amount	Hourly	Daily
Skwk	Skilled Workers Average (35 trades)	$25.95	$207.60	20.2%	16.8%	13.0%	10.0%	60.0%	$15.55	$41.50	$332.00
	Helpers Average (5 trades)	19.25	154.00	21.4		11.0		59.2	11.40	30.65	245.20
	Foreman Average, Inside ($.50 over trade)	26.45	211.60	20.2		13.0		60.0	15.85	42.30	338.40
	Foreman Average, Outside ($2.00 over trade)	27.95	223.60	20.2		13.0		60.0	16.75	44.70	357.60
Clab	Common Building Laborers	19.80	158.40	21.9		11.0		59.7	11.80	31.60	252.80
Asbe	Asbestos Workers	28.55	228.40	19.7		16.0		62.5	17.85	46.40	371.20
Boil	Boilermakers	30.05	240.40	17.7		16.0		60.5	18.20	48.25	386.00
Bric	Bricklayers	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Brhe	Bricklayer Helpers	20.00	160.00	19.4		11.0		57.2	11.45	31.45	251.60
Carp	Carpenters	25.20	201.60	21.9		11.0		59.7	15.05	40.25	322.00
Cefi	Cement Finishers	24.35	194.80	12.8		11.0		50.6	12.30	36.65	293.20
Elec	Electricians	29.30	234.40	8.0		16.0		50.8	14.90	44.20	353.60
Elev	Elevator Constructors	30.05	240.40	9.6		16.0		52.4	15.75	45.80	366.40
Eqhv	Equipment Operators, Crane or Shovel	26.75	214.00	12.9		14.0		53.7	14.35	41.10	328.80
Eqmd	Equipment Operators, Medium Equipment	25.70	205.60	12.9		14.0		53.7	13.80	39.50	316.00
Eqlt	Equipment Operators, Light Equipment	24.70	197.60	12.9		14.0		53.7	13.25	37.95	303.60
Eqol	Equipment Operators, Oilers	21.90	175.20	12.9		14.0		53.7	11.75	33.65	269.20
Eqmm	Equipment Operators, Master Mechanics	27.55	220.40	12.9		14.0		53.7	14.80	42.35	338.80
Glaz	Glaziers	24.90	199.20	16.0		11.0		53.8	13.40	38.30	306.40
Lath	Lathers	24.95	199.60	13.5		11.0		51.3	12.80	37.75	302.00
Marb	Marble Setters	25.65	205.20	19.4		11.0		57.2	14.65	40.30	322.40
Mill	Millwrights	26.55	212.40	13.2		11.0		51.0	13.55	40.10	320.80
Mstz	Mosaic and Terrazzo Workers	25.25	202.00	11.0		11.0		48.8	12.30	37.55	300.40
Pord	Painters, Ordinary	22.95	183.60	16.8		11.0		54.6	12.55	35.50	284.00
Psst	Painters, Structural Steel	23.95	191.60	62.5		11.0		100.3	24.00	47.95	383.60
Pape	Paper Hangers	23.30	186.40	16.8		11.0		54.6	12.70	36.00	288.00
Pile	Pile Drivers	25.35	202.80	33.6		16.0		76.4	19.35	44.70	357.60
Plas	Plasterers	24.20	193.60	17.4		11.0		55.2	13.35	37.55	300.40
Plah	Plasterer Helpers	20.15	161.20	17.4		11.0		55.2	11.10	31.25	250.00
Plum	Plumbers	30.05	240.40	10.2		16.0		53.0	15.95	46.00	368.00
Rodm	Rodmen (Reinforcing)	27.75	222.00	36.3		14.0		77.1	21.40	49.15	393.20
Rofc	Roofers, Composition	22.55	180.40	37.4		11.0		75.2	16.95	39.50	316.00
Rots	Roofers, Tile and Slate	22.60	180.80	37.4		11.0		75.2	17.00	39.60	316.80
Rohe	Roofer Helpers (Composition)	15.95	127.60	37.4		11.0		75.2	12.00	27.95	223.60
Shee	Sheet Metal Workers	28.95	231.60	13.8		16.0		56.6	16.40	45.35	362.80
Spri	Sprinkler Installers	31.30	250.40	10.4		16.0		53.2	16.65	47.95	383.60
Stpi	Steamfitters or Pipefitters	30.30	242.40	10.2		16.0		53.0	16.05	46.35	370.80
Ston	Stone Masons	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Sswk	Structural Steel Workers	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Tilf	Tile Layers	25.05	200.40	11.0		11.0		48.8	12.20	37.25	298.00
Tilh	Tile Layer Helpers	20.30	162.40	11.0		11.0		48.8	9.90	30.20	241.60
Trlt	Truck Drivers, Light	20.35	162.80	17.0		11.0		54.8	11.15	31.50	252.00
Trhv	Truck Drivers, Heavy	20.70	165.60	17.0		11.0		54.8	11.35	32.05	256.40
Sswl	Welders, Structural Steel	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Wrck	*Wrecking	19.80	158.40	44.8		11.0		82.6	16.35	36.15	289.20

*Not included in Averages.

A.3.9-19

City Cost Indexes

	DIVISION	FLORIDA																	
		MIAMI			ORLANDO			PANAMA CITY			PENSACOLA			ST. PETERSBURG			TALLAHASSEE		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.3	72.8	81.5	125.3	85.9	95.0	141.6	83.4	96.9	138.9	85.9	98.1	126.2	85.6	95.0	125.7	85.2	94.6
031	CONCRETE FORMWORK	94.2	71.0	74.5	97.3	71.6	75.5	95.8	37.8	46.6	84.5	69.7	72.0	94.1	64.8	69.3	97.3	53.0	59.7
032	CONCRETE REINFORCEMENT	95.1	72.5	82.4	95.1	79.0	86.0	99.3	64.5	79.7	101.5	64.9	81.0	98.5	74.3	84.9	95.1	65.2	78.3
033	CAST IN PLACE CONCRETE	91.5	75.4	84.6	88.7	78.0	84.1	95.2	43.0	72.9	95.2	69.0	84.0	101.4	70.2	88.1	91.7	58.4	77.5
3	CONCRETE	87.4	74.3	80.8	86.3	76.7	81.4	95.0	46.6	70.5	93.5	70.1	81.7	92.6	70.1	81.2	87.7	59.2	73.3
4	MASONRY	76.9	70.2	72.8	77.4	75.6	76.2	84.9	37.4	55.4	82.6	67.6	73.3	119.2	66.9	86.7	83.6	52.6	64.4
5	METALS	98.8	93.5	96.8	107.9	95.0	103.0	97.2	75.1	88.9	97.1	89.6	94.3	101.0	92.4	97.7	99.2	88.1	95.0
6	WOOD & PLASTICS	88.6	72.7	80.6	94.5	71.1	82.8	92.9	38.3	65.6	80.1	71.1	75.6	90.8	65.2	78.0	94.5	51.6	73.0
7	THERMAL & MOISTURE PROTECTION	99.6	74.6	88.0	96.6	75.6	86.9	96.9	38.3	69.9	96.6	66.9	82.9	96.3	63.1	81.0	96.6	58.8	79.1
8	DOORS & WINDOWS	95.9	69.5	89.5	98.1	68.2	90.9	95.7	35.2	81.2	95.7	66.5	88.7	96.8	60.4	88.0	98.1	53.9	87.4
092	LATH, PLASTER & GYPSUM BOARD	101.0	72.5	82.5	101.6	70.8	81.7	99.7	36.9	59.0	94.5	70.9	79.2	98.9	64.8	76.8	101.6	50.7	68.6
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	72.5	83.0	102.4	70.8	82.0	96.6	36.9	58.0	96.6	70.9	79.9	98.0	64.8	76.5	102.4	50.7	68.9
096	FLOORING & CARPET	121.8	75.3	110.7	113.0	74.9	103.8	112.3	24.6	91.3	106.7	68.0	97.4	111.4	67.8	100.9	113.0	49.7	97.8
099	PAINTING & WALL COVERINGS	100.9	70.1	83.0	104.2	77.6	88.7	104.2	34.5	63.7	104.2	78.5	89.3	104.2	65.4	81.6	104.2	55.7	76.0
9	FINISHES	108.6	71.4	89.7	107.7	72.7	89.9	107.2	34.4	70.2	104.5	70.5	87.2	106.0	65.3	85.3	107.7	51.9	79.3
10-14	TOTAL DIV. 10-14	100.0	81.8	96.1	100.0	83.9	96.6	100.0	65.4	92.6	100.0	73.3	94.3	100.0	76.8	95.1	100.0	74.0	94.5
15	MECHANICAL	100.0	72.9	88.0	100.0	70.8	87.1	100.0	34.6	71.1	100.0	68.8	86.2	100.0	68.7	86.2	100.0	54.8	80.0
16	ELECTRICAL	98.0	84.9	89.3	98.0	63.0	74.6	96.3	47.1	63.5	101.8	63.4	76.2	98.5	68.1	78.2	98.0	58.3	71.5
1-16	WEIGHTED AVERAGE	97.5	76.7	87.4	99.2	75.1	87.6	99.2	48.1	74.5	98.8	71.8	85.7	101.0	71.8	86.9	98.5	62.1	80.9

	DIVISION	FLORIDA			GEORGIA														
		TAMPA			ALBANY			ATLANTA			AUGUSTA			COLUMBUS			MACON		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	126.9	85.6	95.1	110.4	74.2	82.5	114.3	92.8	97.8	110.2	91.5	95.8	110.4	74.3	82.6	111.6	91.9	96.5
031	CONCRETE FORMWORK	97.3	64.9	69.8	96.9	50.8	57.8	98.0	70.3	74.5	94.5	61.8	66.7	96.9	50.4	57.4	95.9	65.9	70.5
032	CONCRETE REINFORCEMENT	95.1	74.3	83.4	95.1	76.4	84.6	98.5	77.5	86.7	104.0	69.1	84.4	95.1	76.4	84.6	97.4	76.7	85.8
033	CAST IN PLACE CONCRETE	101.7	70.2	88.2	95.5	48.9	75.6	101.1	71.2	88.3	95.6	57.9	79.5	95.5	49.5	75.8	95.5	53.3	77.5
3	CONCRETE	92.4	70.2	81.2	89.4	57.0	73.0	94.0	72.1	82.9	90.5	62.2	76.2	89.4	57.0	73.0	89.7	65.1	77.3
4	MASONRY	82.8	66.9	72.9	83.4	38.9	55.7	92.1	63.6	74.4	92.2	49.1	65.4	83.4	39.3	56.0	98.6	46.7	66.4
5	METALS	102.2	92.4	98.5	96.8	89.0	93.9	93.7	74.5	86.4	92.4	69.4	83.7	96.7	89.3	93.9	91.7	90.1	91.1
6	WOOD & PLASTICS	94.5	65.2	79.8	93.7	51.6	72.6	99.7	72.2	86.0	95.9	64.6	80.3	93.7	51.3	72.5	97.4	69.9	83.6
7	THERMAL & MOISTURE PROTECTION	96.6	64.3	81.7	96.4	55.7	77.6	94.2	70.0	83.0	93.6	59.5	77.9	96.1	55.7	77.5	95.1	62.9	80.2
8	DOORS & WINDOWS	98.1	60.4	89.0	95.9	53.7	85.7	94.2	67.9	87.9	90.6	59.3	83.1	95.9	53.8	85.7	94.2	64.8	87.1
092	LATH, PLASTER & GYPSUM BOARD	101.6	64.8	77.7	101.6	50.7	68.6	112.5	72.0	86.2	111.3	64.1	80.7	101.6	50.4	68.4	108.3	69.5	83.2
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	64.8	78.1	102.4	50.7	69.0	108.7	72.0	84.9	108.7	64.1	79.8	102.4	50.4	68.7	95.9	69.5	78.8
096	FLOORING & CARPET	113.0	67.8	102.1	113.0	40.4	95.6	87.8	75.0	84.8	86.7	51.5	78.2	113.0	41.0	95.7	87.8	47.5	78.2
099	PAINTING & WALL COVERINGS	104.2	65.4	81.6	100.9	50.4	71.5	99.0	72.1	83.4	99.0	47.9	69.3	100.9	48.3	70.3	102.4	59.0	77.2
9	FINISHES	107.7	65.3	86.1	105.8	48.1	76.4	95.1	71.5	83.1	94.4	58.6	76.1	105.7	47.8	76.2	91.5	62.0	76.5
10-14	TOTAL DIV. 10-14	100.0	76.8	95.1	100.0	69.5	93.5	100.0	75.4	94.8	100.0	71.0	93.8	100.0	69.4	93.5	100.0	73.6	94.4
15	MECHANICAL	100.0	68.7	86.2	100.0	56.8	80.9	100.1	71.7	87.5	100.1	54.0	79.7	100.0	46.2	76.2	100.0	52.1	78.8
16	ELECTRICAL	97.5	68.1	77.9	93.3	68.1	76.5	93.4	82.3	86.0	96.9	61.3	73.2	93.3	49.4	64.0	91.4	63.3	72.7
1-16	WEIGHTED AVERAGE	99.5	71.8	86.1	97.1	60.8	79.5	96.5	75.0	86.1	95.5	62.5	79.5	97.1	55.7	77.1	95.4	65.4	80.9

	DIVISION	GEORGIA						HAWAII			IDAHO								
		SAVANNAH			VALDOSTA			HONOLULU			BOISE			LEWISTON			POCATELLO		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	SITE WORK	110.6	76.1	84.0	122.0	74.5	85.5	115.0	112.0	112.7	86.4	99.3	96.3	90.4	92.7	92.2	89.1	99.3	96.9
031	CONCRETE FORMWORK	97.0	60.5	66.0	80.8	51.9	56.3	102.1	158.7	150.1	97.4	89.3	90.5	106.3	87.1	90.0	97.4	89.3	90.5
032	CONCRETE REINFORCEMENT	100.7	69.5	83.2	100.8	50.3	72.5	109.9	125.0	118.4	96.0	78.4	86.1	108.6	96.1	101.6	96.3	78.5	86.3
033	CAST IN PLACE CONCRETE	91.5	56.6	76.6	93.0	57.4	77.8	170.2	127.7	152.0	98.6	93.8	96.6	107.8	93.9	101.8	99.6	93.8	97.1
3	CONCRETE	88.3	62.5	75.3	92.8	55.5	74.0	153.0	139.4	146.1	103.2	88.7	95.9	115.5	91.0	103.1	103.7	88.6	96.1
4	MASONRY	86.9	57.6	68.7	89.8	50.6	65.4	131.3	134.3	133.2	131.8	81.0	100.2	128.8	96.6	108.8	136.3	82.7	103.0
5	METALS	97.1	87.6	93.5	96.5	80.7	90.6	117.4	107.6	113.7	112.9	82.2	101.3	96.2	90.7	94.1	112.5	82.2	101.1
6	WOOD & PLASTICS	93.8	60.9	77.3	76.0	50.3	63.1	100.6	165.6	133.1	95.1	88.5	91.8	98.7	83.6	91.2	95.1	88.5	91.8
7	THERMAL & MOISTURE PROTECTION	96.4	59.2	79.3	96.1	60.0	79.5	109.5	133.7	120.6	97.9	84.0	91.5	167.6	89.8	131.7	98.0	83.8	91.5
8	DOORS & WINDOWS	95.9	56.7	86.4	91.4	46.3	80.5	110.6	146.5	119.2	94.9	81.7	91.7	116.3	85.0	108.7	94.9	78.5	91.0
092	LATH, PLASTER & GYPSUM BOARD	101.6	60.4	74.9	93.7	49.4	65.0	95.7	167.7	142.3	89.0	87.9	88.3	135.3	83.0	101.4	89.0	87.9	88.3
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	60.4	75.2	98.0	49.4	66.5	132.8	167.7	155.4	96.2	87.9	90.8	144.9	83.0	104.8	96.2	87.9	90.8
096	FLOORING & CARPET	113.0	60.7	100.4	105.1	48.5	91.5	127.8	128.3	127.9	97.5	74.8	92.1	135.1	97.9	126.2	97.5	74.8	92.1
099	PAINTING & WALL COVERINGS	100.9	59.9	77.0	100.9	43.7	67.6	123.8	148.0	137.9	109.4	67.9	85.2	134.4	91.3	109.3	109.4	78.2	91.3
9	FINISHES	105.8	60.5	82.8	101.9	50.0	75.5	124.5	153.9	139.5	93.2	84.6	88.8	156.4	89.0	122.1	93.2	85.8	89.4
10-14	TOTAL DIV. 10-14	100.0	71.7	94.0	100.0	70.1	93.7	100.0	129.2	106.2	100.0	86.1	97.0	100.0	100.6	100.1	100.0	86.1	97.0
15	MECHANICAL	100.0	55.8	80.5	100.0	48.7	77.3	100.1	119.4	108.6	99.8	85.6	93.5	100.6	94.1	97.7	99.8	85.6	93.5
16	ELECTRICAL	93.3	65.4	74.7	90.2	40.8	57.2	109.7	128.8	122.5	85.2	78.7	80.9	87.5	92.2	90.6	85.7	79.4	81.5
1-16	WEIGHTED AVERAGE	97.2	64.6	81.4	96.8	55.0	76.6	115.9	129.5	122.5	101.0	85.2	93.4	111.9	92.1	102.3	101.3	85.5	93.7

A.3.9-20

ECO NUMBER 10

USE AN ALTERNATIVE HEATING METHOD TO REDUCE SEP OPERATING COST

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-10

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)

INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3

PROJECT NO. & TITLE: ECO-10 ALTERNATIVE HEATING METHODS FOR THE SEP

FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A

ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 6043.		
B. SIOH	$ 363.		
C. DESIGN COST	$ 363.		
D. TOTAL COST (1A+1B+1C)	$ 6769.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 6769.

2. ENERGY SAVINGS (+) / COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 4.	15.08	$ 62.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	111.	$ 149.	14.88	$ 2213.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		111.	$ 153.		$ 2275.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 10102.
   (1) DISCOUNT FACTOR (TABLE A) 14.88
   (2) DISCOUNTED SAVING/COST (3A X 3A1) $ 150318.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 150318.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 10255.

5. SIMPLE PAYBACK PERIOD (1G/4) .66 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 152593.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 22.54
   (IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-10 ALTERNATIVE HEATING METHODS FOR THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 334231.		
B. SIOH	$ 20054.		
C. DESIGN COST	$ 20054.		
D. TOTAL COST (1A+1B+1C)	$ 374339.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 374339.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ -5.	15.08	$ -83.
B. DIST	$ 4.40	-9218.	$ -40559.	18.57	$ -753184.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	24711.	$ 33113.	14.88	$ 492718.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		15493.	$ -7452.		$ -260550.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 12672.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 188559.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 188559.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 5220.

5. SIMPLE PAYBACK PERIOD (1G/4) 71.71 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -71990.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= -.19
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-10XY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-10 ALTERNATIVE HEATING METHODS FOR THE SEP
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 6043.		
B. SIOH	$ 363.		
C. DESIGN COST	$ 363.		
D. TOTAL COST (1A+1B+1C)	$ 6769.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 6769.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ 10070.
(1) DISCOUNT FACTOR (TABLE A)	14.88	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ 149842.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 149842.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 10070.

5. SIMPLE PAYBACK PERIOD (1G/4) .67 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 149842.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 22.14
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

RS&H

SUBJECT: Fort Stewart
Send HTW from CEP to SEP
DESIGNER: G. Fallon
CHECKER:

AEP NO: 694 1331 002
SHEET: OF:
DATE: 2-7-96
DATE:

ECO No. 10 - A DISTRIBUTE HTW FROM CEP TO SEP INSTEAD OF STEAM.

THE HTW SYSTEM OPERATES AT THE SAME TEMPERATURE AS THE STEAM LINE, 375 °F. IF THE STEAM LINE WERE USED TO CONVEY HTW TO THE SEP THE HEAT LOSS FROM THE LINE WOULDN'T CHANGE. THEREFORE THERE WOULD BE NO ENERGY SAVINGS, BUT THERE WOULD BE A SIGNIFICANT DECREASE IN HEATING SEASON OPERATING LABOR.

ENERGY LOSS IN STEAM LINE

ENERGY LOSS DATA FROM SEP TEST SHOWS 3.66 MBTU/HR IN 8750 FT OF PIPE. See Calculation in ECO-12.

$$\text{STEAM LINE LOSS} = 3.66\ \text{MBTU/HR} \times \frac{5280\ \text{ft}}{8760\ \text{ft}} = 2.2\ \text{MBTU/HR}$$

MAX ENERGY REQ'T TO SEP

SEP LOAD = 25.46 MBTU/HR
LINE LOSS TO SEP = 2.2 MBTU/HR
TOTAL ENERGY REQ'T. 27.66 MBTU/HR.

JUMPER LINE SIZE IN CEP

$$\frac{27.66\ \text{MBTU/HR}}{500\ \frac{\text{PPH}}{\text{gpm}} \times (375-230)} = 382\ \text{gpm} \Rightarrow 4''\ \phi\ \text{PIPE}.$$

RETURN LINE ΔP

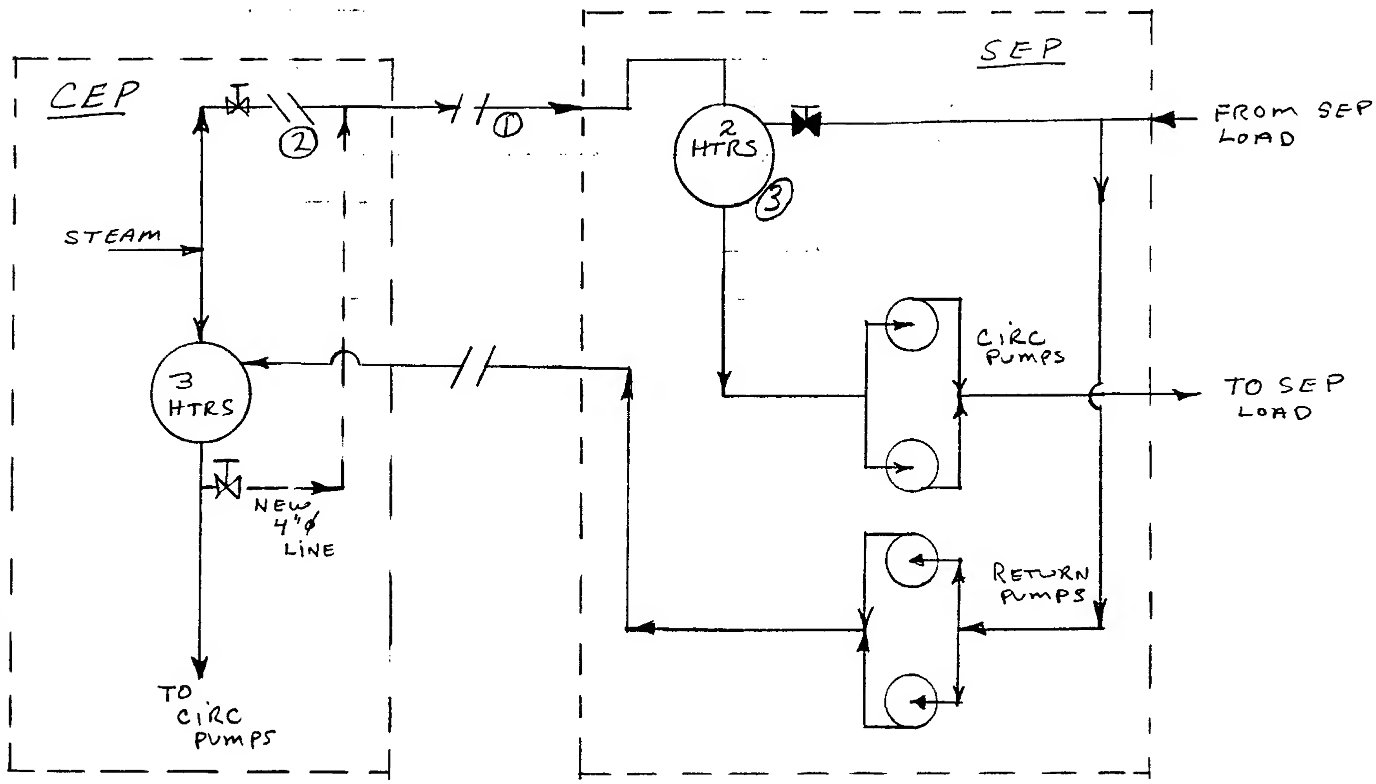
@ 382 gpm ΔP IN 4" LINE = 8ft/100FT pipe. (WORSED CASE)

$$\frac{8\ \text{FT}}{100\ \text{FT}} \times 5280\ \text{FT} = 422\ \text{FT}$$

SUBJECT	Fort Stewart	AEP NO	694 1331 002
	HTW from CCP to SEP	SHEET	OF
DESIGNER	G. Fallon	DATE	2-7-96
CHECKER		DATE	

ECO-10-A

Schematic Diagram



① DISCONNECT STEAM TRAPS; OR, HEAVILY THROTTLE TRAP ISOLATION VALVES TO MINIMIZE, BUT NOT STOP, FLOW THROUGH TRAPS. MINIMAL TRAP FLOW WILL PROTECT DRIP LINE FROM FREEZING.

② BREAK & BLANK EXISTING STEAM LINE AT HEADER.

③ OPERATE HEATERS FULL

Proposed Labor Costs:

Start-up & shut down: assume 50%; $(2069 + $621)/YR × 0.5 = $1345/YR (see next page)

Operating Labor Costs = 1 trip/day × ½ hr/trip × $25.86/hr × 135 day/yr = $ 1746 /YR

O&M Savings = $10473/YR − $1746/YR + $1345/YR = $\boxed{\$10{,}072/\text{YR}}$

RS&H

SUBJECT FORT STEWART AEP NO 694 1331 002
SHEET ____ OF ____
DESIGNER W. Todd DATE 2-1-96
CHECKER ____ DATE ____

ECO-10

Satellite Energy Plant, Operating Costs - Labor

Assumptions:

1) SEP operates for $4\frac{1}{2}$ months / year
2) SEP startup takes 10 days / year
3) SEP shut down takes 3 days / yr
4) Normal operation requires one visit per shift that takes about 1 hour / visit.
5) Start-up and shut-down requires one operator Full time for one shift each day.

Pipefitters hourly rate w/ benefits = \$46.35 mm p 475

Adjusted for Savannah GA = \$46.35 × 0.558 = \$25.86 mm p 533

Labor Costs:

Startup : $10 \frac{\text{days}}{\text{yr}} \times 8 \frac{\text{hrs}}{\text{day}} \times \$25.86/\text{hr} = \underline{\$2069/\text{YR}}$

Operation : $4.5 \frac{\text{mo}}{\text{YR}} \times 30 \frac{\text{day}}{\text{mo}} \times 3 \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \underline{\$10473/\text{YR}}$

Shut down : $3 \frac{\text{day}}{\text{YR}} \times 8 \frac{\text{hr}}{\text{day}} \times \$25.86/\text{hr} = \underline{\$621/\text{YR}}$

Total Labor Cost = \$1034/YR + \$9310/YR + \$621/YR = \$13163/YR

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Distribute HTW from the CEP to the SEP	Date:	02/12/96
ECO Number:	10		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	\$1.34	/MBtu
8. Electricity cost	\$0.0469	/kWh
9. Water cost	\$0.5562	/kGallons

Energy Use Calculations:

Energy Use = flow rate x specific heat x average temperature difference

58094 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 155 °F = 75.1 MBtu/Yr

Heating Fuel Use = 75.1 MBtu/yr / 0.68 = $\boxed{\text{110.5 MBtu/Yr}}$

Heating Fuel Cost = 110.5 MBtu/yr x \$1.34 /MBtu = \$148 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{3.67 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.39 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x Hr/Yr

Electric Demand = 0.39 BHP / 0.90 x 0.746 kW/HP = 0.32 kW

Electricity Use = 0.32 kW x 264 Hr/Yr = 84 kWh/Yr

Electricity Use = 84 kWh/Yr x 0.003413 MBtu/kWh = $\boxed{\text{0.3 MBtu/Yr}}$

Electricity Cost = 84 kWh/Yr x \$0.0469 /kWh = \$4 /Year

Water Cost:

58094 Gal/Yr x \$0.5562 /kGal = $\boxed{\text{\$32 /Year}}$

Total Utility Cost:

Heating Fuel Cost	\$148	/Year
Pumping (Elec) Cost	\$4	/Year
Water Cost	\$32	/Year
Total Utility Cost	\$184	/Year

CONSTRUCTION COST ESTIMATE

Project:	Distribute HTW instead of steam to SEP	RS&H No.:	694-1331-002
Location:	Fort Stewart, GA	Date:	02/14/96
Basis:	Schematic Design	Estimator:	G. W. Fallon
ECO No.:	10A	Filename:	EST-10A.WB2

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Sch. 40 steel pipe, 4"	100	LF	12.75	1275	12.79	1279	2,554	MMp140	MMp140
Insul., 2" CalSil w/cover	100	LF	6.75	675	3.58	358	1,033	MMp236	MMp236
Flange, 300lb, weld nk	4	Ea	25	100	48.75	195	295	MMp165	MMp165
Sch. 40 elbow	6	Ea	17.5	105	97	582	687	MMp159	MMp159
Weldolet Connection, 4"	2	Ea	46.75	94	72	144	238	MMp163	MMp163
Gate Valve, 4", 300 lb	1	Ea	1100	1100	32.50	33	1,133	MMp197	MMp197
Subtotal Bare Costs				3349		2591	$5,940		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				3349		2591	5,940		
City Cost Index (Sav. GA)			0%	0	-44%	-1145	(1,145)	MMp533	MMp533
Subtotal				3349		1446	4,795		
OH & Profit Markups			10%	335	53%	766	1,101	MMp7	MMp475
Subtotal				3684		2212	5,896		
Sales Taxes			4.0%	147		NA	147	MMp476	
Total Construction Cost				3831		2212	6,043		
Design Fee				NA	6.0%	363	363		
SIOH				NA	6.0%	363	363		
Subtotal				3831		2938	6,769		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				3831		2938	$6,769		

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.

RS&H

SUBJECT	FORT STEWART SHUT DOWN THE SEP	AEP NO	694 1331 002
		SHEET	1 OF
DESIGNER	W. TODD	DATE	2-7-96
CHECKER		DATE	

ECO-10-B SHUT DOWN THE SEP

SEP - Estimated Building Loads

Assumptions :

1) 2" diameter HTW supply pipe to building
2) Flow based on pipe friction pressure drop of 3ft/100 ft which is in the upper end of general design range.
3) The HTW temperature difference across the heat exchanger is ~ $180° - 60° = 120°F$

Heating Load :

Load = Flow × specific heat × temp. diff.

Flow ≈ 40 gal/min from ASHRAE Friction Loss chart

$$40 \frac{gal}{min} \times 8.34 \frac{lb}{gal} \times 60 \frac{min}{hr} \times 1 \frac{Btu}{lb\,°F} \times 120°F = 2401920 \frac{Btu}{hr}$$

$$2401920 \frac{Btu}{hr} \times 1\ MBtu/10^6\ Btu = 2.4\ MBtu/hr \text{ per bldg.}$$

The cost estimate is based on 5 boilers of this size.

Heat Loss from HTW Piping

Assumptions :

1) Average HTW and steam pipe size is 6" dia.
2) Heat loss from dry insulated pipes is ~55 Btu/HR·FT
3) Heat loss from pipes with deteriorated and moist insulation is 275 Btu/HR·FT
4) Source is Ft. McClellan study (see attached pages)
5) Length of SEP piping is 17500 feet.
6) 50% of the sep piping is dry w/good insulation.

RS&H

SUBJECT	FORT STEWART	AEP NO	694 1331 002
	SHUT DOWN THE SEP	SHEET	2 OF
DESIGNER	W. TODD	DATE	2-7-96
CHECKER		DATE	

ECO-10-B

Heat Loss from HTW/steam piping (continued)

Current Heat Loss:

$$17500 \text{ LF} \times 0.5 \times 55 \text{ Btu/HR} \cdot \text{LF} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 0.481 \text{ mBtu/HR}$$

$$17500 \text{ LF} \times 0.5 \times 275 \text{ Btu/HR} \cdot \text{LF} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = 2.406 \text{ mBtu/HR}$$

$$\text{Annual heat loss} = (0.481 + 2.406) \frac{\text{mBtu}}{\text{HR}} \times 135 \frac{\text{day}}{\text{YR}} \times 24 \frac{\text{hr}}{\text{day}} = 9354 \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Annual Fuel Use} = 9354 \frac{\text{mBtu}}{\text{YR}} \div 0.68 = \underline{13756 \frac{\text{mBtu}}{\text{YR}}}$$

Operating Energy Costs:

The operating energy use will be the same for both systems, however, the cost of fuel oil is \$4.40/mBtu and the cost of CEP fuels (average) is \$1.34/mBtu.

Bin temperature data was used to estimate the heating energy used in the 5 buildings (see attached table)

Current Energy Cost (CEP HEATING FUELS):

$$7374 \text{ mBtu/YR} \div 0.68 = \underline{10844 \frac{\text{mBtu}}{\text{YR}}} \times \$1.34/\text{mBtu} = \$14531/\text{YR}$$

Proposed Energy Cost (FUEL OIL NO. 2):

$$7374 \frac{\text{mBtu}}{\text{YR}} \div 0.80 = \underline{9218 \frac{\text{mBtu}}{\text{YR}}} \times \$4.40/\text{mBtu} = \$40{,}557/\text{YR}$$

ECO-10-B

O&M Costs for new boilers

Assume 1 hour per month per boiler for maintenance.

$$1\ \frac{HR}{MO} \times 4\ \frac{MO}{YR} \times 5\ \text{BOILERS} \times \$25.86/HR = \underline{\$517/YR}$$

Pumping Energy

Assume the new circulating pumps will be the same size at the existing HHW circ. pumps in the buildings.

SEP Zone HTW Pump:

$$\text{Heating energy} = 7374\ \frac{mBtu}{YR} \times \frac{1\ YR}{135\ day} \times \frac{1\ day}{24\ HR} \times \frac{1\ HR}{60\ min} = 37932\ \frac{Btu}{HR}$$

$$lb/HR = \frac{37932\ \frac{Btu}{HR}}{1\ \frac{Btu}{lb\ °F} \times 120\ °F} = 316\ \frac{lb}{HR} \times \frac{1\ GAL}{8.34\ lb} \times \frac{1\ HR}{60\ min} = 0.63\ GPM$$

$$BHP = \frac{0.63 \times 300'\ HD}{3960 \times 0.72} = 0.07\ BHP \div 0.9 \times 0.746\ \frac{KW}{BHP} = 0.06\ KW$$

$$0.06\ KW \times 135\ \frac{day}{YR} \times 24\ \frac{HR}{day} \times 3413\ \frac{Btu}{KWH} \times \frac{1\ mBtu}{10^6\ Btu} = \underline{0.7\ mBtu/YR}$$

RS&H

SUBJECT	FORT STEWART SHUT DOWN SEP	AEP NO	694 1331 002
		SHEET	OF
DESIGNER	W. TODD	DATE	2-7-96
CHECKER		DATE	

ECO-10 B

ANNUAL SAVINGS (INCREASE)

HEATING FUELS = 111 + 13756 + 10844 = $\boxed{24711 \frac{\text{MBtu}}{\text{YR}}}$

ELECTRICITY = 0.3 − 0.7 = $\boxed{(0.4)\ \text{MBtu/YR}}$

FUEL OIL = $\boxed{(9218)\ \text{MBtu/YR}}$

WATER = $\boxed{\$32\ /\text{YR}}$

O&M = 13163 − 517 = $\boxed{\$12{,}646\ /\text{YR}}$

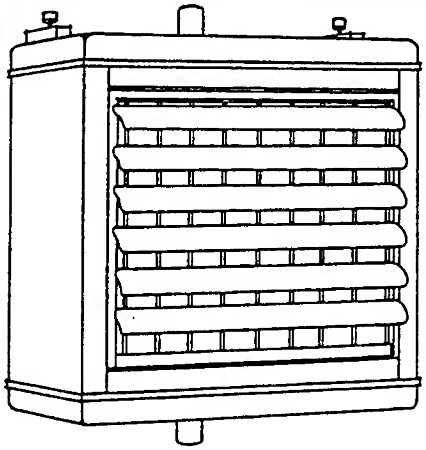
CONSTRUCTION COST ESTIMATE

Project: Shut Down SEP, Install Small Boilers
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 10B

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-10B.WB2

	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL	SOURCE	
ITEM DESCRIPTION	No.	Unit	$/Unit	Total	$/Unit	Total	COST	Material	Labor
Hydronic Heating with	5	Ea	47664	238320	20853	104265	342,585	MMp370	MMp370
Boiler, oil fired, 2.4 MB								MMp370	MMp370
Circulating pump								MMp370	MMp370
Expansion tank								MMp370	MMp370
Oil tank, above ground								MMp370	MMp370
Valves and fittings								MMp370	MMp370
Boiler Breeching								MMp370	MMp370
Fuel oil piping system								MMp370	MMp370
Sch 40 steel pipe								MMp370	MMp370
Insul., Cal.Sil., 1" wall								MMp370	MMp370
Boiler Shed, 20' x 8'	5	Ea	5200	26000	415	2075	28,075	MMp10	MMp10
Subtotal Bare Costs				264320		106340	$370,660		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				264320		106340	370,660		
City Cost Index (Sav. GA)			0%	0	-44%	-47002	(47,002)	MMp533	MMp533
Subtotal				264320		59338	323,658		
OH & Profit Markups			0%	0	0%	0	0	Included	Included
Subtotal				264320		59338	323,658		
Sales Taxes			4.0%	10573		NA	10,573	MMp476	
Total Construction Cost				274893		59338	334,231		
Design Fee				NA	6.0%	20054	20,054		
SIOH				NA	6.0%	20054	20,054		
Subtotal				274893		99446	374,339		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				274893		99446	$374,339		

LEGEND:
MMp### 1996 Means Mechanical Cost Data, page ###.



Unit Heater

Fossil Fuel Boiler System Considerations:

1. Terminal units are horizontal unit heaters. Quantities are varied to accommodate total heat loss per building.
2. Unit heater selection was determined by their capacity to circulate the building volume a minimum of three times per hour in addition to the BTU output.
3. Systems shown are forced hot water. Steam boilers cost slightly more than hot water boilers. However, this is compensated for by the smaller size or fewer terminal units required with steam.
4. Floor levels are based on 10' story heights.
5. MBH requirements are gross boiler output.

System Components	QUANTITY	UNIT	COST EACH MAT.	COST EACH INST.	COST EACH TOTAL
SYSTEM 8.3-141-1280					
HEATING SYSTEM, HYDRONIC, FOSSIL FUEL, TERMINAL UNIT HEATERS					
CAST IRON BOILER, GAS, 80 MBH, 1,070 S.F. BUILDING					
Boiler, gas, hot water, CI, burner, controls & insulation 80 MBH	1.000	Ea.	1,300	970	2,270
Pipe, steel, black, schedule 40, threaded, cplg & hngr 10'OC, 2" diam	50 ~~200.000~~	L.F.	247 ~~988~~	518 ~~2,070~~	~~3,058~~
Unit heater, 1 speed propeller, horizontal, 200° EWT, 72.7 MBH	2.000	Ea.	0 ~~1,900~~	0 ~~191~~	~~2,091~~
Unit heater piping hookup with controls	2.000	Set	0 ~~640~~	0 ~~1,580~~	~~2,220~~
Boiler breeching	1.000	System	65	48.50	113.50
Expansion tank, painted steel, ASME, 18 Gal capacity	1.000	Ea.	1,250	55.50	1,305.50
Circulating pump, CI, flange connection, 1/12 HP	1.000	Ea.	198	110	308
Pipe covering, calcium silicate w/cover, 1" wall, 2" diam	50 ~~200.000~~	L.F.	145 ~~580~~	209 ~~836~~	~~1,416~~
TOTAL			3205 ~~6,921~~	1911 ~~5,861~~	5116 12,782
COST PER S.F.			~~6.47~~ 0.463	~~5.48~~ 0.326	~~11.95~~

8.3-141	Heating Systems, Unit Heaters	COST PER S.F. MAT.	COST PER S.F. INST.	COST PER S.F. TOTAL
1260	Heating systems, hydronic, fossil fuel, terminal unit heaters,			
1280	Cast iron boiler, gas, 80 M.B.H., 1,070 S.F. bldg.	6.45	5.50	11.95
1320	163 M.B.H., 2,140 S.F. bldg. R155-010	4.41	3.72	8.13
1360	544 M.B.H., 7,250 S.F. bldg.	3.04	2.58	5.62
1400	1,088 M.B.H., 14,500 S.F. bldg. R155-020	2.71	2.46	5.17
1440	3,264 M.B.H., 43,500 S.F. bldg.	2.29	1.84	4.13
1480	5,032 M.B.H., 67,100 S.F. bldg. R155-030	2.48	1.91	4.39
1520	Oil, 109 M.B.H., 1,420 S.F. bldg.	6.40	4.87	11.27
1560	235 M.B.H., 3,150 S.F. bldg.	4.24	3.52	7.76
1600	940 M.B.H., 12,500 S.F. bldg.	3.20	2.25	5.45
1640	1,600 M.B.H., 21,300 S.F. bldg.	3.10	2.14	5.24
1680	2,480 M.B.H., 33,100 S.F. bldg. 3.10×.463 = 1.44 ; 1.94×.326=0.63	1.44 ~~3.10~~	0.63 ~~1.94~~	~~5.04~~
1720	3,350 M.B.H., 44,500 S.F. bldg.	2.74	1.99	4.73
1760	Coal, 148 M.B.H., 1,975 S.F. bldg. Mat = 1.44 × 33100 = 47644	4.70	3.20	7.90
1800	300 M.B.H., 4,000 S.F. bldg.	3.68	2.50	6.18
1840	2,360 M.B.H., 31,500 S.F. bldg. Lab = 0.63×33100 = 20853	2.69	2.01	4.70
1880	Steel boiler, gas, 72 M.B.H., 1,020 S.F. bldg.	5.85	4.06	9.91
1920	240 M.B.H., 3,200 S.F. bldg.	4.18	3.22	7.40
1960	480 M.B.H., 6,400 S.F. bldg.	3.39	2.38	5.77
2000	800 M.B.H., 10,700 S.F. bldg.	2.99	2.13	5.12
2040	1,960 M.B.H., 26,100 S.F. bldg.	2.69	1.91	4.60
2080	3,000 M.B.H., 40,000 S.F. bldg.	2.66	1.95	4.61

A.3.10-15

rS

To →/ From ↓	ΔP				ΔP/L			ΔP/ρ		ΔP/ρL		
	psi	psf	Pa	kPa	(psi/ 100 ft)	(Pa/ m)	(kPa/ m)	ft (1)	(J/ kg)	(ft/ 100 ft)	(milinch/ ft)	(J/ kg m)
psi	1	144	6890	6.89	—	—	—	—	—	—	—	—
psf	0.00694	1	4.79	0.00479	—	—	—	—	—	—	—	—
Pa	0.000145	0.209	1	0.001	—	—	—	—	—	—	—	—
kPa	0.145	209	1000	1	—	—	—	—	—	—	—	—
(psi/ 100 ft)	—	—	—	—	1	226	0.226	—	—	—	—	—
(Pa/ m)	—	—	—	—	0.00442	1	0.001	—	—	—	—	—
(KPa/ m)	—	—	—	—	4.42	1000	1	—	—	—	—	—
ft (1)	—	—	—	—	—	—	—	1	3.00	—	—	—
(J/ kg)	—	—	—	—	—	—	—	0.344	1	—	—	—
(ft/ 100 ft)	—	—	—	—	—	—	—	—	—	1	120	0.0983
(milinch/ ft)	—	—	—	—		—	—	—	—	0.00833	1	0.000819
(J/ kg m)	—	—	—	—	—	—	—	—	—	10.2	1220.7	1

(1) (ft-lb/lb) = ft

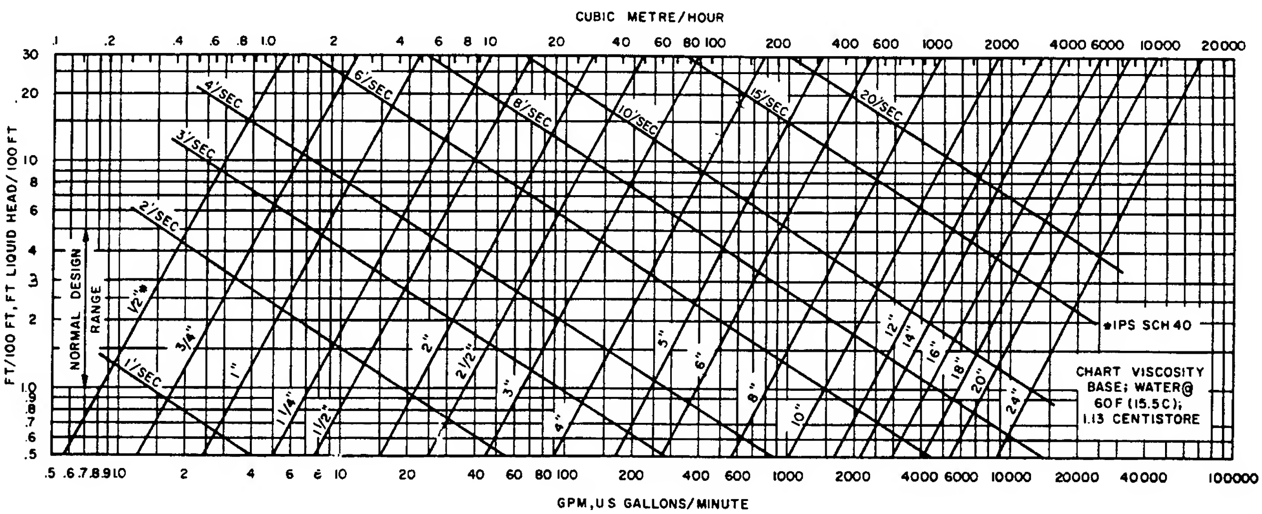


Fig. 1 Friction Loss for Water in Commercial Steel Pipe (Schedule 40)

system must be equipped with air separation devices to minimize the amount of entrained air in the piping circuit. Air should be vented at the highest point of the sytem.

In the absence of such venting, air can be entrained in the water and carried to separation units at flow velocities of 1.5 to 2 fps or more in pipe sizes 2 in. and under. Minimum velocities of 2 fps are therefore recommended. For pipe sizes 2 in. and over, minimum velocities corresponding to .75 ft/100 ft (.75 m/100 m) are normally used. Particular attention to maintenance of minimum velocities should be observed in the upper floors of high rise buildings when the air may tend to come out of solution because of the reduced pressures. Higher velocities should be used in *down-comer* return mains feeding into air separation units located in the basement.

Example 1: Determine pipe size for circuit requiring 20 gpm flow.

Solution: Enter Fig. 1 at 20 gpm, read up to pipe size within normal design range, select 1 1/2 in. Velocity is 3.1 fps which is between 2-4. Pressure loss is 2.9 ft/100 ft which is between 1-4 ft/100 ft.

Valve and Fitting Pressure Drop

Valve and fitting pressure drop is usually listed in elbow equivalents. The elbow equivalent simply relates pressure

2.7

drop through a valve or fitting to an equivalent pipe length. The pressure drop of one elbow is approximately the same as that of a length of straight pipe 25 times the pipe diameter. The following simple rule-of-thumb is often used: the equivalent length of pipe in feet for an elbow equals 2 times nominal pipe diameter (inches). Thus, a 1-in. elbow = 2 equivalent ft of 1-in. pipe, a 4-in. elbow = 8 equivalent ft of 4-in. pipe, etc.

A more accurate determination, related to water flow velocity, is listed in Table 2.

Elbow equivalents for valves and fittings for iron and copper are shown in Table 3.

Example 2: Determine equivalent feet of pipe for a 4-in. open gate valve at a flow velocity of approximately 4 fps.

Solution: From Table 2, at 4 fps, each equivalent elbow is equal to 10.6 ft of 4-in. pipe. From Table 3, the 4-in. gate valve is equal to 0.5 elbows. The actual equivalent pipe length (added to measure circuit length for pressure drop determination) will be 10.6 × 0.5, or 5.3 equivalent feet of 4-in. pipe.

Tee Fitting Pressure Drop. Pressure drop through pipe tees varies with flow through the branch. Pressure drops are illustrated in Fig. 3 for tees of equal inlet and outlet sizes, and for the flow patterns illustrated.

A.3.10-16

CONF-8406132--2

ANALYSIS OF A SMALL DISTRICT STEAM SYSTEM AT FT. McCLELLAN, ALABAMA

CONF-8406132

DE84 014051

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Mount Washington, New Hampshire

June 17-20, 1984

MASTER

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A.3.10-17

Of the total steam produced, we estimate that approximately 95% enters the steam distribution system. The remaining 5% is used within the boiler plants to power auxiliaries. This amounts to some 570 lb/hr on the average or 5.0 million lb/yr. Then approximately 96 million lb/yr enters the distribution system.

5. CAUSES FOR HEAT LOSS FROM BURIED PIPE

In order to minimize heat losses from steam and condensate pipe lines, the lines are usually insulated. Sometimes the pipes may run above ground but more commonly, the pipes are buried from two to six feet below the surface. If the insulation is intact and dry, the ground helps to insulate the pipe from cold temperatures in the winter and to reduce the heat losses. In this section, we present estimates of the heat losses for well insulated pipes as well as for pipes with deteriorated insulation and under various failure conditions.

Heat Loss From Dry, Insulated, Buried Pipes. Heat losses have been calculated for varied soil conditions and various types of insulation by King et. al. [3]. For the example of a six-inch steam line at 325°F with four inches of calcium silicate insulation in clay of average moisture and a soil temperature of 50°F, the rate of heat loss would be approximately 55 Btu/hour per linear foot of pipe. For the Ft. McClellan system with a steam temperature of 338°F and a ground temperature of 80°F, the loss rate would be about 52 Btu/hr-ft.

Heat Loss From Bare Pipes in Air. The simplest case to consider is a bare pipe exposed to ambient air on a dry, still day. For this case, the two major heat loss mechanisms are natural convection and radiation. We consider the case of a six-inch pipe with 338°F steam and ambient air at 150°F (a typical temperature inside a dry vault, where much of the bare pipe is found). The estimated loss due to natural convection under these conditions is about 350 Btu/hour per foot of pipe. Kreith [4] in Table 5.1 gives a value of emissivity of 0.8 for oxidized steel pipe. For the same pipe, the estimated radiation loss is approximately 570 Btu/hr-ft. The total loss per foot of bare pipe under these circumstances is then 920 Btu/hr-ft.

Buried Pipes With Entrapped Moisture and Deteriorated Insulation. Observations of actual buried steam lines indicates that the heat losses are substantially higher than the theoretical losses. Consideration of the magnitudes of the observed losses suggests that the pipe is behaving as though there were no insulation, and that the pipe is in direct contact with the surrounding soil. The most likely physical explanation is that the conductivity has been greatly enhanced by the deterioration of the insulation from the combined effects of heat and moisture that gets into the system by steam leaks or the intrusion of ground water. Entrapped moisture could be boiling near the surface of the pipe and condensing on the jacket, or subcooled boiling and the formation of a thermal convection loop in water filling the space between the pipe and jacket could be occurring. Both these processes produce extremely high heat transfer rates compared to the rate through dry insulation. If it is assumed that the conductivity of the insulation is infinite, the model of King et al. yields a heat transfer factor of about 1.8 Btu/hr-°F per foot of six-inch diameter pipe. For the six-inch pipe at 338°F and a 80°F ground temperature, the rate of heat loss per foot of pipe would be 460 Btu/hr-ft. This compares with the observed value of about 275 Btu/hr-ft.

Heat Loss From Flooding of Vaults. A commonly observed failure of steam lines is the failure of sump pumps in valve pits and the subsequent covering of the steam pipe with water. The source of the water can be either condensate from steam traps, which collects in the vault and causes flooding when sump pumps fail, or intrusion of ground water into the pits through cracks in the pit wall or around pipes that penetrate the pit walls. Water in the vaults is commonly heated to temperatures that are rather hot; we assume here that the water in the vault is heated to 150°F. The estimated rate of heat loss from a bare, six-inch steam pipe carrying 338°F steam and covered by 150°F water is 50,000 Btu/hr-ft. (This estimate could be higher, perhaps as high as 150,000 Btu/hr-ft depending on the assumed heat transfer mechanism.) Notice that the loss is nearly sixty times as large as the loss from dry, bare pipe. Perhaps even more interesting, the rate of heat loss would be 190 times greater than the

Fort Stewart – Central Energy Plant
Filename: FS-VPDIS.WQ1
12/15/95

Approximate Distance Between Valve Pits (1)

	ZONE 1		ZONE 2N		ZONE 2S		ZONE 3		SEP ZONE			
	PIT#	LN.FT.	PIT#	LN.FT.	PIT#	LN.FT.	PIT#	LN.FT.	PIT#	LN.FT.		
	CP–B1	200	CP–V1	150	V1–B1	700	CP–?	700	C1–V1	1500	(2)	
	B1–V4	1000	V1–V2	200	B1–V1	1500	?–1	800	V1–V2	100	(2)	
	V1–V2	600	V2–V3	350	V1–B2	300	?–2	400	V2–V3	1700	(2)	
	V2–V3	200	V3–V4	650	B2–B3	550	2–2A	400	V3–V4	450	(2)	
	V3–V4	350	V4–V5	600	B3–V1	250	2A–3	500	V4–V5	600	(2)	
	V4–V5	300	V5–V6	800	V1–V2	250	3–3A	400	V5–V6	500	(2)	
	V5–V6	550	V6–V7	800	V1–V3	350	3A–6	550	V6–SP	100	(2)	
	V6–V7	400	V2–V8	750	V3–V4	250	4–5	900	SP–V7	200		
	V7–V8	600	V8–V9	300	V3–V6	300	5–6	650	V7–V8	150		
	V8–V9	350			V4–V5	200	6–7	850	V8–V9	550		
	V9–V10	350			V3–V7	650	7–8	950	V9–V10	650		
	V10–V11	250			V7–V8	250	8–9	1000	V10–V11	800		
	V11–V12	500			V8–V9	500	9–10	1000	V11–V12	650		
	V12–V13	1000			V9–V10	200	10–11	900	V12–V13	800		
	V13–V14	350			V9–V11	450	11–12	500				
	V14–V15	400					12–13	950				
	V15–V16	400					13–13A	750				
	V16–V17	500					12–14	950				
	V17–V18	800					14–15	200				
							15–16	250				
							16–16A	300				
							16A–17	200				
							17–18	200				
							18–19	100				
							19–20	150				
							20–22	200				
							21–22	100				
							22–23	350				
							15–24C	350				
							24C–24B	200				
							24B–24	200				
							24–24A	200				
							24A–25	150				
							24A–25A	300				
							25A–26	100				
							26–26A	200				
							26A–27	250				
							27–28	250				
TOTAL LN.FT.		9100		4600		6700		17400		8750		
MILES		1.7		0.9		1.3		3.3		1.7		8.8
MAX LNFT/VP		1000		800		1500		1000		1700		
AVG LNFT/VP		479		511		447		458		625		490
MIN LNFT/VP		200		150		200		100		100		
NO. OF PITS (1)		19		9		15		38		14		95

(1) There are other valve boxes and drain pits that are not shown on our HTW system map.

(2) These pipes carry steam.

HEATING SEASON ENERGY CONSUMPTION FOR SEP BUILDINGS

					SEP Building Number				4502	4577	4578	4528	3002	Total
					Pipe size feeding building				2"dia	2"dia	1.5"dia.	1.25" dia.	1" dia.	
					GPM flow rate at 3 ft/100 ft				40	40	20	13	7	
					Max Heat delivery (MBtu/Hr)				2.4	2.4	1.2	0.8	0.4	7.21
Temp.	Hours in Temperature Range													
Range	Nov	Dec	Jan	Feb	Mar	Total	Time (%)	Load (%)	MBTU					
60/64	130	87	88	103	135	543	18.4%	10.0%	130	130	65	42	23	391
55/59	118	100	105	101	118	542	18.3%	20.0%	260	260	130	85	46	781
50/54	101	115	106	106	110	538	18.2%	30.0%	388	388	194	126	68	1,163
45/49	77	112	109	102	77	477	16.1%	40.0%	458	458	229	149	80	1,375
40/44	50	101	111	70	57	389	13.2%	50.0%	467	467	234	152	82	1,402
35/39	27	71	76	44	29	247	8.4%	60.0%	356	356	178	116	62	1,068
30/34	9	46	45	27	11	138	4.7%	70.0%	232	232	116	75	41	696
25/29	2	21	25	10	2	60	2.0%	80.0%	115	115	58	37	20	346
20/24	1	7	9	2		19	0.6%	90.0%	41	41	21	13	7	123
15/19		1	2	1		4	0.1%	100.0%	10	10	5	3	2	29
					Total	2957	100.0%		2,458	2,458	1,229	799	430	7,374

HUNTER AAF/SAVANNAH GEORGIA

Temperature Range	NOVEMBER Obsn Hour Gp 01 to 08	NOVEMBER 09 to 16	NOVEMBER 17 to 24	NOVEMBER Total Obsn	NOVEMBER M C W B	DECEMBER Obsn Hour Gp 01 to 08	DECEMBER 09 to 16	DECEMBER 17 to 24	DECEMBER Total Obsn	DECEMBER M C W B	JANUARY Obsn Hour Gp 01 to 08	JANUARY 09 to 16	JANUARY 17 to 24	JANUARY Total Obsn	JANUARY M C W B
105/109															
100/104															
95/99															
90/94															
85/89		0		0	70							0		0	69
80/84		7	0	7	69		1		1	68		1		1	68
75/79		26	2	28	66		6		6	66		7	1	8	66
70/74	1	45	11	57	63		19	1	20	62	0	17	3	20	63
65/69	21	49	45	115	61	8	31	17	56	61	4	27	11	42	60
60/64	38	44	48	130	57	18	40	29	87	56	19	37	32	88	57
55/59	38	34	46	118	53	24	40	36	100	52	28	39	38	105	52
50/54	44	20	37	101	48	29	40	46	115	47	30	37	39	106	47
45/49	39	10	28	77	43	36	33	43	112	43	32	35	42	109	43
40/44	31	4	15	50	39	42	22	37	101	38	45	25	41	111	38
35/39	19	1	7	27	34	39	10	22	71	34	37	15	24	76	34
30/34	7	0	2	9	30	30	5	11	46	29	28	5	12	45	29
25/29	2		0	2	25	16	1	4	21	25	17	3	5	25	25
20/24	1			1	22	6	0	1	7	21	7	1	1	9	20
15/19						1	0	0	1	16	2	0	0	2	17
10/14						0			0	12	0	0		0	10

Temperature Range	FEBRUARY Obsn Hour Gp 01 to 08	FEBRUARY 09 to 16	FEBRUARY 17 to 24	FEBRUARY Total Obsn	FEBRUARY M C W B	MARCH Obsn Hour Gp 01 to 08	MARCH 09 to 16	MARCH 17 to 24	MARCH Total Obsn	MARCH M C W B	APRIL Obsn Hour Gp 01 to 08	APRIL 09 to 16	APRIL 17 to 24	APRIL Total Obsn	APRIL M C W B	ANNUAL TOTAL Obsn Hour Gp 01 to 08	ANNUAL TOTAL 09 to 16	ANNUAL TOTAL 17 to 24	ANNUAL TOTAL Total Obsn	ANNUAL TOTAL M C W B
105/109																	0		0	79
100/104																	3	0	3	78
95/99																	30	3	33	78
90/94							0	0	0	69		1	0	1	73	0	157	23	180	77
85/89							2	1	3	68		8	1	9	69	3	390	90	483	75
80/84		3	0	3	66		10	2	12	67		33	5	38	68	56	454	272	782	73
75/79		10	2	12	64	0	25	5	30	64	1	59	18	78	66	374	391	510	1275	71
70/74	0	23	5	28	62	1	38	15	54	61	15	56	46	117	64	545	331	413	1289	68
65/69	6	36	19	61	60	21	44	38	103	60	51	42	71	164	61	351	289	349	989	62
60/64	30	35	38	103	57	40	45	50	135	56	65	27	52	144	58	341	263	322	926	57
55/59	28	36	37	101	52	39	34	45	118	52	45	11	26	82	53	274	206	259	739	52
50/54	32	32	42	106	47	45	23	42	110	47	28	4	15	47	48	244	160	239	643	48
45/49	38	25	39	102	43	35	15	27	77	43	25	1	6	32	44	227	120	192	539	43
40/44	35	13	22	70	39	35	7	15	57	38	9		1	10	40	207	71	134	412	38
35/39	25	7	12	44	34	20	4	5	29	34	2		0	2	36	145	37	70	252	34
30/34	19	3	5	27	30	9	0	2	11	30	0			0	33	93	13	32	138	29
25/29	8	1	1	10	25	2	0	0	2	26						45	5	10	60	25
20/24	2	0	0	2	21	0			0	20						16	1	2	19	21
15/19	1	0		1	15											4	0	0	4	16
10/14																0	0		0	11

A.3.10-21

Installing Contractor's Overhead & Profit

Below are the average installing contractor's percentage mark-ups applied to base labor rates to arrive at typical billing rates.

Column A: Labor rates are based on union wages averaged for 30 major U.S. cities. Base rates including fringe benefits are listed hourly and daily. These figures are the sum of the wage rate and employer-paid fringe benefits such as vacation pay, employer-paid health and welfare costs, pension costs, plus appropriate training and industry advancement funds costs.

Column B: Workers' Compensation rates are the national average of state rates established for each trade.

Column C: Column C lists average fixed overhead figures for all trades. Included are Federal and State Unemployment costs set at 7.3%; Social Security Taxes (FICA) set at 7.65%; Builder's Risk Insurance costs set at 0.34%; and Public Liability costs set at 1.55%. All the percentages except those for Social Security Taxes vary from state to state as well as from company to company.

Columns D and E: Percentages in Columns D and E are based on the presumption that the installing contractor has annual billing of $500,000 and up. Overhead percentages may increase with smaller annual billing. The overhead percentages for any given contractor may vary greatly and depend on a number of factors, such as the contractor's annual volume, engineering and logistical support costs, and staff requirements. The figures for overhead and profit will also vary depending on the type of job, the job location, and the prevailing economic conditions. All factors should be examined very carefully for each job.

Column F: Column F lists the total of Columns B, C, D, and E.

Column G: Column G is Column A (hourly base labor rate) multiplied by the percentage in Column F (O&P percentage).

Column H: Column H is the total of Column A (hourly base labor rate) plus Column G (Total O&P).

Column I: Column I is Column H multiplied by eight hours.

		A		B	C	D	E	F	G	H	I
		Base Rate Incl. Fringes		Workers' Comp. Ins.	Average Fixed Overhead	Overhead	Profit	Total Overhead & Profit		Rate with O & P	
Abbr.	Trade	Hourly	Daily					%	Amount	Hourly	Daily
Skwk	Skilled Workers Average (35 trades)	$25.95	$207.60	20.2%	16.8%	13.0%	10%	60.0%	$15.55	$41.50	$332.00
	Helpers Average (5 trades)	19.25	154.00	21.4		11.0		59.2	11.40	30.65	245.20
	Foreman Average, Inside ($.50 over trade)	26.45	211.60	20.2		13.0		60.0	15.85	42.30	338.40
	Foreman Average, Outside ($2.00 over trade)	27.95	223.60	20.2		13.0		60.0	16.75	44.70	357.60
Clab	Common Building Laborers	19.80	158.40	21.9		11.0		59.7	11.80	31.60	252.80
Asbe	Asbestos Workers	28.55	228.40	19.7		16.0		62.5	17.85	46.40	371.20
Boil	Boilermakers	30.05	240.40	17.7		16.0		60.5	18.20	48.25	386.00
Bric	Bricklayers	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Brhe	Bricklayer Helpers	20.00	160.00	19.4		11.0		57.2	11.45	31.45	251.60
Carp	Carpenters	25.20	201.60	21.9		11.0		59.7	15.05	40.25	322.00
Cefi	Cement Finishers	24.35	194.80	12.8		11.0		50.6	12.30	36.65	293.20
Elec	Electricians	29.30	234.40	8.0		16.0		50.8	14.90	44.20	353.60
Elev	Elevator Constructors	30.05	240.40	9.6		16.0		52.4	15.75	45.80	366.40
Eqhv	Equipment Operators, Crane or Shovel	26.75	214.00	12.9		14.0		53.7	14.35	41.10	328.80
Eqmd	Equipment Operators, Medium Equipment	25.70	205.60	12.9		14.0		53.7	13.80	39.50	316.00
Eqlt	Equipment Operators, Light Equipment	24.70	197.60	12.9		14.0		53.7	13.25	37.95	303.60
Eqol	Equipment Operators, Oilers	21.90	175.20	12.9		14.0		53.7	11.75	33.65	269.20
Eqmm	Equipment Operators, Master Mechanics	27.55	220.40	12.9		14.0		53.7	14.80	42.35	338.80
Glaz	Glaziers	24.90	199.20	16.0		11.0		53.8	13.40	38.30	306.40
Lath	Lathers	24.95	199.60	13.5		11.0		51.3	12.80	37.75	302.00
Marb	Marble Setters	25.65	205.20	19.4		11.0		57.2	14.65	40.30	322.40
Mill	Millwrights	26.55	212.40	13.2		11.0		51.0	13.55	40.10	320.80
Mstz	Mosaic & Terrazzo Workers	25.25	202.00	11.0		11.0		48.8	12.30	37.55	300.40
Pord	Painters, Ordinary	22.95	183.60	16.8		11.0		54.6	12.55	35.50	284.00
Psst	Painters, Structural Steel	23.95	191.60	62.5		11.0		100.3	24.00	47.95	383.60
Pape	Paper Hangers	23.30	186.40	16.8		11.0		54.6	12.70	36.00	288.00
Pile	Pile Drivers	25.35	202.80	33.6		16.0		76.4	19.35	44.70	357.60
Plas	Plasterers	24.20	193.60	17.4		11.0		55.2	13.35	37.55	300.40
Plah	Plasterer Helpers	20.15	161.20	17.4		11.0		55.2	11.10	31.25	250.00
Plum	Plumbers	30.05	240.40	10.2		16.0		53.0	15.95	46.00	368.00
Rodm	Rodmen (Reinforcing)	27.75	222.00	36.3		14.0		77.1	21.40	49.15	393.20
Rofc	Roofers, Composition	22.55	180.40	37.4		11.0		75.2	16.95	39.50	316.00
Rots	Roofers, Tile & Slate	22.60	180.80	37.4		11.0		75.2	17.00	39.60	316.80
Rohe	Roofers, Helpers (Composition)	15.95	127.60	37.4		11.0		75.2	12.00	27.95	223.60
Shee	Sheet Metal Workers	28.95	231.60	13.8		16.0		56.6	16.40	45.35	362.80
Spri	Sprinkler Installers	31.30	250.40	10.4		16.0		53.2	16.65	47.95	383.60
Stpi	Steamfitters or Pipefitters	30.30	242.40	10.2		16.0		53.0	16.05	46.35	370.80
Ston	Stone Masons	25.90	207.20	19.4		11.0		57.2	14.80	40.70	325.60
Sswk	Structural Steel Workers	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Tilf	Tile Layers	25.05	200.40	11.0		11.0		48.8	12.20	37.25	298.00
Tilh	Tile Layers Helpers	20.30	162.40	11.0		11.0		48.8	9.90	30.20	241.60
Trlt	Truck Drivers, Light	20.35	162.80	17.0		11.0		54.8	11.15	31.50	252.00
Trhv	Truck Drivers, Heavy	20.70	165.60	17.0		11.0		54.8	11.35	32.05	256.40
Sswl	Welders, Structural Steel	27.85	222.80	46.4		14.0		87.2	24.30	52.15	417.20
Wrck	*Wrecking	19.80	158.40	44.8		11.0		82.6	16.35	36.15	289.20

*Not included in Averages.

City Cost Indexes

DIVISION		FLORIDA																	
		MIAMI			ORLANDO			PANAMA CITY			PENSACOLA			ST. PETERSBURG			TALLAHASSEE		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	**SITE WORK**	110.3	72.8	81.5	125.3	85.9	95.0	141.6	83.4	96.9	138.9	85.9	98.1	126.2	85.6	95.0	125.7	85.2	94.6
031	CONCRETE FORMWORK	94.2	71.0	74.5	97.3	71.6	75.5	95.8	37.8	46.6	84.5	69.7	72.0	94.1	64.8	69.3	97.3	53.0	59.7
032	CONCRETE REINFORCEMENT	95.1	72.5	82.4	95.1	79.0	86.0	99.3	64.5	79.7	101.5	64.9	81.0	98.5	74.3	84.9	95.1	65.2	78.3
033	CAST IN PLACE CONCRETE	91.5	75.4	84.6	88.7	78.0	84.1	95.2	43.0	72.9	95.2	69.0	84.0	101.4	70.2	88.1	91.7	58.4	77.5
3	**CONCRETE**	87.4	74.3	80.8	86.3	76.7	81.4	95.0	46.6	70.5	93.5	70.1	81.7	92.6	70.1	81.2	87.7	59.2	73.3
4	**MASONRY**	76.9	70.2	72.8	77.4	75.6	76.2	84.9	37.4	55.4	82.6	67.6	73.3	119.2	66.9	86.7	83.6	52.6	64.4
5	**METALS**	98.8	93.5	96.8	107.9	95.0	103.0	97.2	75.1	88.9	97.1	89.6	94.3	101.0	92.4	97.7	99.2	88.1	95.0
6	**WOOD & PLASTICS**	88.6	72.7	80.6	94.5	71.1	82.8	92.9	38.3	65.6	80.1	71.1	75.6	90.8	65.2	78.0	94.5	51.6	73.0
7	**THERMAL & MOISTURE PROTECTION**	99.6	74.6	88.0	96.6	75.6	86.9	96.9	38.3	69.9	96.6	66.9	82.9	96.3	63.1	81.0	96.6	58.8	79.1
8	**DOORS & WINDOWS**	95.9	69.5	89.5	98.1	68.2	90.9	95.7	35.2	81.2	95.7	66.5	88.7	96.8	60.4	88.0	98.1	53.9	87.4
092	LATH, PLASTER & GYPSUM BOARD	101.0	72.5	82.5	101.6	70.8	81.7	99.7	36.9	59.0	94.5	70.9	79.2	98.9	64.8	76.8	101.6	50.7	68.6
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	72.5	83.0	102.4	70.8	82.0	96.6	36.9	58.0	96.6	70.9	79.9	98.0	64.8	76.5	102.4	50.7	68.9
096	FLOORING & CARPET	121.8	75.3	110.7	113.0	74.9	103.8	112.3	24.6	91.3	106.7	68.0	97.4	111.4	67.8	100.9	113.0	49.7	97.8
099	PAINTING & WALL COVERINGS	100.9	70.1	83.0	104.2	77.6	88.7	104.2	34.5	63.7	104.2	78.5	89.3	104.2	65.4	81.6	104.2	55.7	76.0
9	**FINISHES**	108.6	71.4	89.7	107.7	72.7	89.9	107.2	34.4	70.2	104.5	70.5	87.2	106.0	65.3	85.3	107.7	51.9	79.3
10-14	**TOTAL DIV. 10-14**	100.0	81.8	96.1	100.0	83.9	96.6	100.0	65.4	92.6	100.0	73.3	94.3	100.0	76.8	95.1	100.0	74.0	94.5
15	**MECHANICAL**	100.0	72.9	88.0	100.0	70.8	87.1	100.0	34.6	71.1	100.0	68.8	86.2	100.0	68.7	86.2	100.0	54.8	80.0
16	**ELECTRICAL**	98.0	84.9	89.3	98.0	63.0	74.6	96.3	47.1	63.5	101.8	63.4	76.2	98.5	68.1	78.2	98.0	58.3	71.5
1-16	**WEIGHTED AVERAGE**	97.5	76.7	87.4	99.2	75.1	87.6	99.2	48.1	74.5	98.8	71.8	85.7	101.0	71.8	86.9	98.5	62.1	80.9

DIVISION		FLORIDA			GEORGIA														
		TAMPA			ALBANY			ATLANTA			AUGUSTA			COLUMBUS			MACON		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	**SITE WORK**	126.9	85.6	95.1	110.4	74.2	82.5	114.3	92.8	97.8	110.2	91.5	95.8	110.4	74.3	82.6	111.6	91.9	96.5
031	CONCRETE FORMWORK	97.3	64.9	69.8	96.9	50.8	57.8	98.0	70.3	74.5	94.5	61.8	66.7	96.9	50.4	57.4	95.9	65.9	70.5
032	CONCRETE REINFORCEMENT	95.1	74.3	83.4	95.1	76.4	84.6	98.5	77.5	86.7	104.0	69.1	84.4	95.1	76.4	84.6	97.4	76.7	85.8
033	CAST IN PLACE CONCRETE	101.7	70.2	88.2	95.5	48.9	75.6	101.1	71.2	88.3	95.6	57.9	79.5	95.5	49.5	75.8	95.5	53.3	77.5
3	**CONCRETE**	92.4	70.2	81.2	89.4	57.0	73.0	94.0	72.1	82.9	90.5	62.2	76.2	89.4	57.0	73.0	89.7	65.1	77.3
4	**MASONRY**	82.8	66.9	72.9	83.4	38.9	55.7	92.1	63.6	74.4	92.2	49.1	65.4	83.4	39.3	56.0	98.6	46.7	66.4
5	**METALS**	102.2	92.4	98.5	96.8	89.0	93.9	93.7	74.5	86.4	92.4	69.4	83.7	96.7	89.3	93.9	91.7	90.1	91.1
6	**WOOD & PLASTICS**	94.5	65.2	79.8	93.7	51.6	72.6	99.7	72.2	86.0	95.9	64.6	80.3	93.7	51.3	72.5	97.4	69.9	83.6
7	**THERMAL & MOISTURE PROTECTION**	96.6	64.3	81.7	96.4	55.7	77.6	94.2	70.0	83.0	93.6	59.5	77.9	96.1	55.7	77.5	95.1	62.9	80.2
8	**DOORS & WINDOWS**	98.1	60.4	89.0	95.9	53.7	85.7	94.2	67.9	87.9	90.6	59.3	83.1	95.9	53.8	85.7	94.2	64.8	87.1
092	LATH, PLASTER & GYPSUM BOARD	101.6	64.8	77.7	101.6	50.7	68.6	112.5	72.0	86.2	111.3	64.1	80.7	101.6	50.4	68.4	108.3	69.5	83.2
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	64.8	78.1	102.4	50.7	69.0	108.7	72.0	84.9	108.7	64.1	79.8	102.4	50.4	68.7	95.9	69.5	78.8
096	FLOORING & CARPET	113.0	67.8	102.1	113.0	40.4	95.6	87.8	75.0	84.8	86.7	51.5	78.2	113.0	41.0	95.7	87.8	47.5	78.2
099	PAINTING & WALL COVERINGS	104.2	65.4	81.6	100.9	50.4	71.5	99.0	72.1	83.4	99.0	47.9	69.3	100.9	48.3	70.3	102.4	59.0	77.2
9	**FINISHES**	107.7	65.3	86.1	105.8	48.1	76.4	95.1	71.5	83.1	94.4	58.6	76.1	105.7	47.8	76.2	91.5	62.0	76.5
10-14	**TOTAL DIV. 10-14**	100.0	76.8	95.1	100.0	69.5	93.5	100.0	75.4	94.8	100.0	71.0	93.8	100.0	69.4	93.5	100.0	73.6	94.4
15	**MECHANICAL**	100.0	68.7	86.2	100.0	56.8	80.9	100.1	71.7	87.5	100.1	54.0	79.7	100.0	46.2	76.2	100.0	52.1	78.8
16	**ELECTRICAL**	97.5	68.1	77.9	93.3	68.1	76.5	93.4	82.3	86.0	96.9	61.3	73.2	93.3	49.4	64.0	91.4	63.3	72.7
1-16	**WEIGHTED AVERAGE**	99.5	71.8	86.1	97.1	60.8	79.5	96.5	75.0	86.1	95.5	62.5	79.5	97.1	55.7	77.1	95.4	65.4	80.9

DIVISION		GEORGIA						HAWAII			IDAHO								
		SAVANNAH			VALDOSTA			HONOLULU			BOISE			LEWISTON			POCATELLO		
		MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL	MAT.	INST.	TOTAL
2	**SITE WORK**	110.6	76.1	84.0	122.0	74.5	85.5	115.0	112.0	112.7	86.4	99.3	96.3	90.4	92.7	92.2	89.1	99.3	96.9
031	CONCRETE FORMWORK	97.0	60.5	66.0	80.8	51.9	56.3	102.1	158.7	150.1	97.4	89.3	90.5	106.3	87.1	90.0	97.4	89.3	90.5
032	CONCRETE REINFORCEMENT	100.7	69.5	83.2	100.8	50.3	72.5	109.9	125.0	118.4	96.0	78.4	86.1	108.6	96.1	101.6	96.3	78.5	86.3
033	CAST IN PLACE CONCRETE	91.5	56.6	76.6	93.0	57.4	77.8	170.2	127.7	152.0	98.6	93.8	96.6	107.8	93.9	101.8	99.6	93.8	97.1
3	**CONCRETE**	88.3	62.5	75.3	92.8	55.5	74.0	153.0	139.4	146.1	103.2	88.7	95.9	115.5	91.0	103.1	103.7	88.6	96.1
4	**MASONRY**	86.9	57.6	68.7	89.8	50.6	65.4	131.3	134.3	133.2	131.8	81.0	100.2	128.8	96.6	108.8	136.3	82.7	103.0
5	**METALS**	97.1	87.6	93.5	96.5	80.7	90.6	117.4	107.6	113.7	112.9	82.2	101.3	96.2	90.7	94.1	112.5	82.2	101.1
6	**WOOD & PLASTICS**	93.8	60.9	77.3	76.0	50.3	63.1	100.6	165.6	133.1	95.1	88.5	91.8	98.7	83.6	91.2	95.1	88.5	91.8
7	**THERMAL & MOISTURE PROTECTION**	96.4	59.2	79.3	96.1	60.0	79.5	109.5	133.7	120.6	97.9	84.0	91.5	167.6	89.8	131.7	98.0	83.8	91.5
8	**DOORS & WINDOWS**	95.9	56.7	86.4	91.4	46.3	80.5	110.6	146.5	119.2	94.9	81.7	91.7	116.3	85.0	108.7	94.9	78.5	91.0
092	LATH, PLASTER & GYPSUM BOARD	101.6	60.4	74.9	93.7	49.4	65.0	95.7	167.7	142.3	89.0	87.9	88.3	135.3	83.0	101.4	89.0	87.9	88.3
095	ACOUSTICAL TREATMENT & WOOD FLOORING	102.4	60.4	75.2	98.0	49.4	66.5	132.8	167.7	155.4	96.2	87.9	90.8	144.9	83.0	104.8	96.2	87.9	90.8
096	FLOORING & CARPET	113.0	60.7	100.4	105.1	48.5	91.5	127.8	128.3	127.9	97.5	74.8	92.1	135.1	97.9	126.2	97.5	74.8	92.1
099	PAINTING & WALL COVERINGS	100.9	59.9	77.0	100.9	43.7	67.6	123.8	148.0	137.9	109.4	67.9	85.2	134.4	91.3	109.3	109.4	78.2	91.3
9	**FINISHES**	105.8	60.5	82.8	101.9	50.0	75.5	124.5	153.9	139.5	93.2	84.6	88.8	156.4	89.0	122.1	93.2	85.8	89.4
10-14	**TOTAL DIV. 10-14**	100.0	71.7	94.0	100.0	70.1	93.7	100.0	129.2	106.2	100.0	86.1	97.0	100.0	100.6	100.1	100.0	86.1	97.0
15	**MECHANICAL**	100.0	55.8	80.5	100.0	48.7	77.3	100.1	119.4	108.6	99.8	85.6	93.5	100.6	94.1	97.7	99.8	85.6	93.5
16	**ELECTRICAL**	93.3	65.4	74.7	90.2	40.8	57.2	109.7	128.8	122.5	85.2	78.7	80.9	87.5	92.2	90.6	85.7	79.4	81.5
1-16	**WEIGHTED AVERAGE**	97.2	64.6	81.4	96.8	55.0	76.6	115.9	129.5	122.5	101.0	85.2	93.4	111.9	92.1	102.3	101.3	85.5	93.7

A.3.10-23

COST INDEXES

ECO NUMBER 11

CONTRACT WITH A LEAK DETECTION SERVICE OR PURCHASE LEAK LOCATING EQUIPMENT FOR USE WHEN A MAJOR HTW LEAK OCCURS

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-11
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-11 PURCHASE LEAK DETECTION EQUIPMENT
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 55500.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 55500.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 55500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 1.	15.08	$ 21.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	76.	$ 102.	14.88	$ 1511.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		76.	$ 103.		$ 1532.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 5658.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 84191.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 84191.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 5761.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.63 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 85723.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.54
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

WITH ECO's 9A & 12A

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-11X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-11 PURCHASE LEAK DETECTION EQUIPMENT
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 55500.	
B. SIOH	$ 0.	
C. DESIGN COST	$ 0.	
D. TOTAL COST (1A+1B+1C)	$ 55500.	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0.	
F. PUBLIC UTILITY COMPANY REBATE	$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)		$ 55500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 1.	15.08	$ 21.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	66.	$ 88.	14.88	$ 1306.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		66.	$ 89.		$ 1327.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 5658.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 84191.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 84191.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 5747.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.66 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 85518.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.54
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

WITH ECO'S 9A, 12A & 12B

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-11Y
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-11 PURCHASE LEAK DETECTION EQUIPMENT
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 05-06-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 55500.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 55500.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 55500.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 1.	15.08	$ 21.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	58.	$ 78.	14.88	$ 1156.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		58.	$ 79.		$ 1177.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 5658.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 84191.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 84191.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 5737.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.67 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 85368.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.54
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

RS&H	SUBJECT: Fort Stewart / Purchase Leak Correlator	AEP NO: 694 1331 002	
	DESIGNER: W. Todd	SHEET: 1	OF:
	CHECKER:	DATE: 2-7-96	DATE: Rev. 4-12-96

ECO-11 PURCHASE LEAK CORRELATOR

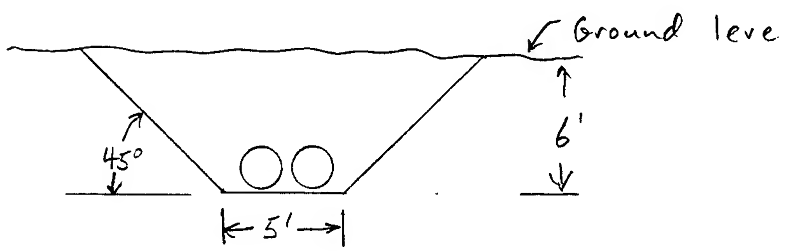
W/o Leak Correlator

Assume 3 dig and cut operations are required to find a typical HTW leak.

Average distance between valve pits:

$$\frac{9100\text{ lf} + 4600\text{ lf} + 6700\text{ lf} + 17400\text{ lf} + 8750\text{ lf}}{95\text{ Valve Pits}} = 490\text{ LF/pit}$$

Area of excavation: Assume 1 dig is 20' long and:



$6' \times 11' \times 20' = 1320\ \text{Ft}^3 \div 27\ \frac{CF}{CY} = 48.9 \Rightarrow \text{say } 50\ \frac{CY}{DIG} \times 3\ \text{DIGS} = 150\ CY$

Using a combination of backhoe and hand excavation and assuming 60% (150 × 0.6 = 90 cy) will be done by backhoe and 40% (150 × 0.4 = 60 cy) will be done by hand. The time required to find the leak is:

Backhoe : 90 CY × 0.080 hr/cy ÷ 24 hr/day ≈ 0.3 day (96MM p28)

By Hand : 60 CY × 1.5 hr/cy ÷ 24 hr/day ÷ 4men ≈ 0.94 day (96mm p28)

HTW Lost : (See graph of 1995 Make-up water use)

Average loss during leak = 25000 GPD
Average 1995 Make-up use = 10000 GPD

(25000 GPD − 10000 GPD) × 1.24 Day/leak ≈ 18,560 Gal/leak

RS&H

SUBJECT Fort Stewart	AEP NO 694 1331 002
Purchase Leak Correlator	SHEET 2 OF
DESIGNER W. Todd	DATE 2-7-96
CHECKER	DATE Rev. 4-12-96

ECO-11

With Leak Correlator

Assume only have to dig 20 linear feet. Vendor indicated leak could be located within inches (see call confermation) on the first dig.

Area of excavation:

$6' \times 11' \times 20' = 1320\ CF \div 27\ CF/CY = 49 \Rightarrow 50\ CY$

Assume 60 % will be done by backhoe; $50 \times 0.6 = 30\ CY$
Assume 40 % will be done by hand; $50 \times 0.4 = 20\ CY$

Time Required:
By hand: $20\ CY \times 1.5\ \frac{hr}{CY} \div 4\ men \div 24\ hr/day = 0.31\ day$ (96MM p28)
W/ backhoe: $30\ CY \times 0.080\ hr/CY \div 24\ hr/day = 0.1\ day$ (96MM p28)

Assume 4 hours for leak correlator test

$0.31\ day + 0.1\ day + 0.17\ day = 0.58\ days/leak$

HTW Lost:

$(25000\ GPD - 10000\ GPD) \times 0.\ \ day = 8,650\ Gal/leak$

RS&H

SUBJECT: FORT STEWART — PURCHASE LEAK CORRELATOR
DESIGNER: W. TODD
CHECKER:
AEP NO: 694 1331 002
SHEET: 3 OF
DATE: 2-7-96
DATE: Rev. 4-12-96

ECO - 11

W/o Leak Correlator:

O&M Costs = (From estimate EST-11B.WB2 = $9133 /YR

HTW Losses = 18,560 $\frac{\text{GAL}}{\text{Leak}}$ × 2 $\frac{\text{leaks}}{\text{YR}}$ = 37,120 $\frac{\text{GAL}}{\text{YR}}$

Heating Fuel Use = 141.2 mBtu/YR

Electricity Use = 54 $\frac{\text{kwh}}{\text{YR}}$ × 0.003413 $\frac{\text{mBtu}}{\text{kwh}}$ = 0.2 $\frac{\text{mBtu}}{\text{YR}}$

Water Cost = 37,120 $\frac{\text{Gal}}{\text{YR}}$ × $0.5562/1000 GAL = $21 /YR

With Leak Correlator:

O&M Costs = (from estimate EST-11A.WB2 = $3486/YR

HTW Losses = 8650 $\frac{\text{GAL}}{\text{Leak}}$ × 2 $\frac{\text{leaks}}{\text{YR}}$ = 17300 GAL/YR

Heating Fuel Use = 65.8 mBtu/YR

Electricity Use = 25 $\frac{\text{kwh}}{\text{YR}}$ × 0.003413 $\frac{\text{mBtu}}{\text{kwh}}$ = 0.1 $\frac{\text{mBtu}}{\text{YR}}$

Water Cost = 17,300 $\frac{\text{GAL}}{\text{YR}}$ × $0.5562/1000 GAL = $10/YR

ANNUAL SAVINGS

HEATING FUELS = 141.2 − 65.8 = 75.8 mBtu/YR
ELECTRICITY = 0.2 − 0.1 = 0.1 mBtu/YR
WATER = $21 − $10 = $11 /YR
O&M = $9133 − $3486 = $5647 /YR

CONSTRUCTION COST ESTIMATE

Project: Repair HTW Piping Leaks
Location: Fort Stewart, GA
Basis: Schematic Design
ECO Number: 11

RS&H No.: 694-1331-002
Date: 04/12/96
Estimator: W.T.Todd
Filename: EST-11A.WB2

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Shut off HTW zone	4	MH	0	0	30.30	121	121		MMp475
Perform leak locator test	4	MH	0	0	30.30	121	121		MMp475
Excavation, backhoe to 6'	30	CY	1.43	43	1.82	55	98	MMp28	MMp28
Excavation, by hand to 6'	20	CY	0	0	29.65	593	593	MMp28	MMp28
Remove conduit, torch	6	LF	1.06	6	4.95	30	36	MMp22	MMp22
Remove pipe insulation	2	LF	0	0	4.84	10	10		MMp236
Valve off and drain pipe	0.50	MH	0	0	30.30	15	15		MMp475
Repair HTW leak - Weld	1	Ea	1.95	2	16.05	16	18	MMp144	MMp144
Open valves - fill pipe	0.50	Ea	0	0	30.30	15	15		MMp475
Replace pipe insulation	2	LF	0	0	4.84	10	10		MMp236
Weld conduit, 24" Sch 40	1	Ea	35	35	289	289	324	MMp144	MMp144
Backfill trench, by hand	20	CY		0	12.85	257	257	MMp28	MMp28
Compact backfill, by hand	20	CY		0	4.66	93	93	MMp28	MMp28
Backfill trench, dozer	30	CY	0.95	29	0.32	10	39	MMp28	MMp28
Compact backfill, dozer	30	CY	1.37	41	0.41	12	53	MMp28	MMp28
Total Cost per Leak				156		1647	1,803		
Total Cost for All Leaks	2	Ea	156	312	1647	3294	3,606		
Subtotal Bare Costs				312		3294	$3,606		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				312		3294	3,606		
City Cost Index (Sav. GA)			0%	0	-44%	-1456	(1,456)	MMp533	MMp533
Subtotal				312		1838	2,150		
OH & Profit Markups			10%	31	53%	974	1,005	MMp7	MMp475
Subtotal				343		2812	3,155		
Sales Taxes			4.0%	14		NA	14	MMp476	
Subtotal				357		2812	3,169		
Contingency			10%	36	10%	281	317	MEp6	MEp6
Total Construction Cost				393		3093	3,486		
Design Fee				NA	0.0%	0	0		
SIOH				NA	0.0%	0	0		
Total Project Cost				393		3093	$3,486		

LEGEND:
MEp### 1996 Means Electrical Cost Data, page ###.
MMp### 1996 Means Mechanical Cost Data, page ###.

CONSTRUCTION COST ESTIMATE

Project:	Repair HTW Piping Leaks	RS&H No.:	694-1331-002
Location:	Fort Stewart, GA	Date:	04/12/96
Basis:	Schematic Design	Estimator:	W.T.Todd
ECO Number: 11		Filename:	EST-11B.WB2

ITEM DESCRIPTION	QUANTITY No.	Unit	MATERIAL/EQUIP $/Unit	Total	LABOR $/Unit	Total	TOTAL COST	SOURCE Material	Labor
Shut off HTW zone	4	MH	0	0	30.30	121	121		MMp475
Excavation, backhoe to 6'	90	CY	1.43	129	1.82	164	293	MMp28	MMp28
Excavation, by hand to 6'	60	CY	0	0	29.65	1779	1,779	MMp28	MMp28
Remove conduit, torch	18	LF	1.06	19	4.95	89	108	MMp22	MMp22
Remove pipe insulation	6	LF	0	0	4.84	29	29		MMp236
Valve off and drain pipe	0.50	MH	0	0	30.30	15	15		MMp475
Repair HTW leak - Weld	1	Ea	1.95	2	16.05	16	18	MMp144	MMp144
Open valves - fill pipe	0.50	Ea	0	0	30.30	15	15		MMp475
Replace pipe insulation	6	LF	0	0	4.84	29	29		MMp236
Weld conduit, 24" Sch 40	3	Ea	35	105	289	867	972	MMp144	MMp144
Backfill trench, by hand	60	CY		0	12.85	771	771	MMp28	MMp28
Compact backfill, by hand	60	CY		0	4.66	280	280	MMp28	MMp28
Backfill trench, dozer	90	CY	0.95	86	0.32	29	115	MMp28	MMp28
Compact backfill, dozer	90	CY	1.37	123	0.41	37	160	MMp28	MMp28
Total Cost per Leak				464		4241	4,705		
Total Cost for All Leaks	2	Ea	464	928	4241	8482	9,410		
Subtotal Bare Costs				928		8482	$9,410		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				928		8482	9,410		
City Cost Index (Sav. GA)			0%	0	-44%	-3749	(3,749)	MMp533	MMp533
Subtotal				928		4733	5,661		
OH & Profit Markups			10%	93	53%	2508	2,601	MMp7	MMp475
Subtotal				1021		7241	8,262		
Sales Taxes			4.0%	41		NA	41	MMp476	
Subtotal				1062		7241	8,303		
Contingency			10%	106	10%	724	830	MEp6	MEp6
Total Construction Cost				1168		7965	9,133		
Design Fee				NA	0.0%	0	0		
SIOH				NA	0.0%	0	0		
Total Project Cost				1168		7965	$9,133		

LEGEND:

MEp### 1996 Means Electrical Cost Data, page ###.

MMp### 1996 Means Mechanical Cost Data, page ###.

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Without Leak Locating Equipment	Date:	05/06/96
ECO Number:	11		

Assumptions:

1.	HTW temperature	380	°F
2.	Make-up water temperature	70	°F
3.	Boiler efficiency	68%	
4.	Pump head (from record drawings)	300	Ft H20
5.	Pump efficiency (from record drawings)	72%	
6.	Motor efficiency	90%	
7.	Average heating fuel cost	$1.34	/MBtu
8.	Electricity cost	$0.0469	/kWh
9.	Water cost	$0.5562	/kGallons

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

37120 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 96.0 MBtu/Yr

Heating Fuel Use = 96.0 MBtu/yr / 0.68 = 141.2 MBtu/Yr

Heating Fuel Cost = 141.2 MBtu/yr x $1.34 /MBtu = $189 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.07 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.01 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.01 BHP / 0.90 x 0.746 kW/HP = 0.01 kW

Electricity Use = 0.01 kW x 8760 Hr/Yr = 54 kWh/Yr

Electricity Cost = 54 kWh/Yr x $0.0469 /kWh = $3 /Year

Water Cost:

37120 Gal/Yr x $0.5562 /kGal = $21 /Year

Total Utility Cost Savings:

Heating Fuel Cost	$189	/Year
Pumping (Elec) Cost	$3	/Year
Water Cost	$21	/Year
Total Savings	$213	/Year

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	With Leak Locating Equipment	Date:	05/06/96
ECO Number:	11		

Assumptions:

1.	HTW temperature	380	°F
2.	Make-up water temperature	70	°F
3.	Boiler efficiency	68%	
4.	Pump head (from record drawings)	300	Ft H20
5.	Pump efficiency (from record drawings)	72%	
6.	Motor efficiency	90%	
7.	Average heating fuel cost	$1.34	/MBtu
8.	Electricity cost	$0.0469	/kWh
9.	Water cost	$0.5562	/kGallons

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

17300 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 44.8 MBtu/Yr

Heating Fuel Use = 44.8 MBtu/yr / 0.68 = 65.8 MBtu/Yr

Heating Fuel Cost = 65.8 MBtu/yr x $1.34 /MBtu = $88 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.03 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.003 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.003 BHP / 0.90 x 0.746 kW/HP = 0.003 kW

Electricity Use = 0.003 kW x 8760 Hr/Yr = 25 kWh/Yr

Electricity Cost = 25 kWh/Yr x $0.0469 /kWh = $1 /Year

Water Cost:

17300 Gal/Yr x $0.5562 /kGal = $10 /Year

Total Utility Cost Savings:

Heating Fuel Cost	$88	/Year
Pumping (Elec) Cost	$1	/Year
Water Cost	$10	/Year
Total Savings	$99	/Year

Fort Stewart – Central Energy Plant
Filename: FS-VPDIS.WQ1
12/15/95

Approximate Distance Between Valve Pits (1)

ZONE 1 PIT#	ZONE 1 LN.FT.	ZONE 2N PIT#	ZONE 2N LN.FT.	ZONE 2S PIT#	ZONE 2S LN.FT.	ZONE 3 PIT#	ZONE 3 LN.FT.	SEP ZONE PIT#	SEP ZONE LN.FT.	
CP–B1	200	CP–V1	150	V1–B1	700	CP–?	700	C1–V1	1500	(2)
B1–V4	1000	V1–V2	200	B1–V1	1500	?–1	800	V1–V2	100	(2)
V1–V2	600	V2–V3	350	V1–B2	300	?–2	400	V2–V3	1700	(2)
V2–V3	200	V3–V4	650	B2–B3	550	2–2A	400	V3–V4	450	(2)
V3–V4	350	V4–V5	600	B3–V1	250	2A–3	500	V4–V5	600	(2)
V4–V5	300	V5–V6	800	V1–V2	250	3–3A	400	V5–V6	500	(2)
V5–V6	550	V6–V7	800	V1–V3	350	3A–6	550	V6–SP	100	(2)
V6–V7	400	V2–V8	750	V3–V4	250	4–5	900	SP–V7	200	
V7–V8	600	V8–V9	300	V3–V6	300	5–6	650	V7–V8	150	
V8–V9	350			V4–V5	200	6–7	850	V8–V9	550	
V9–V10	350			V3–V7	650	7–8	950	V9–V10	650	
V10–V11	250			V7–V8	250	8–9	1000	V10–V11	800	
V11–V12	500			V8–V9	500	9–10	1000	V11–V12	650	
V12–V13	1000			V9–V10	200	10–11	900	V12–V13	800	
V13–V14	350			V9–V11	450	11–12	500			
V14–V15	400					12–13	950			
V15–V16	400					13–13A	750			
V16–V17	500					12–14	950			
V17–V18	800					14–15	200			
						15–16	250			
						16–16A	300			
						16A–17	200			
						17–18	200			
						18–19	100			
						19–20	150			
						20–22	200			
						21–22	100			
						22–23	350			
						15–24C	350			
						24C–24B	200			
						24B–24	200			
						24–24A	200			
						24A–25	150			
						24A–25A	300			
						25A–26	100			
						26–26A	200			
						26A–27	250			
						27–28	250			

	ZONE 1	ZONE 2N	ZONE 2S	ZONE 3	SEP ZONE	
TOTAL LN.FT.	9100	4600	6700	17400	8750	
MILES	1.7	0.9	1.3	3.3	1.7	8.8
MAX LNFT/VP	1000	800	1500	1000	1700	
AVG LNFT/VP	479	511	447	458	625	
MIN LNFT/VP	200	150	200	100	100	
NO. OF PITS (1)	19	9	15	38	14	95

(1) There are other valve boxes and drain pits that are not shown on our HTW system map.
(2) These pipes carry steam.

CONSTRUCTION COST ESTIMATE

Project: Purchase Leak Detection Equipment
Location: Fort Stewart, GA
Basis: Schematic Design
ECO No.: 11

RS&H No.: 694-1331-002
Date: 02/14/96
Estimator: W.T.Todd
Filename: EST-11.WQ1

ITEM DESCRIPTION	QUANTITY No.	QUANTITY Unit	MATERIAL/EQUIP $/Unit	MATERIAL/EQUIP Total	LABOR $/Unit	LABOR Total	TOTAL COST	SOURCE Material	SOURCE Labor
Leak Correlator w/ 2									
sensors/transmittors	1	Ea	51000	51000		0	51,000	Vendor	
4.5 day on-site class									
room and field work									
training session	1	Ea		0	4500	4500	4,500		Vendor
Subtotal Bare Costs				51000		4500	$55,500		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				51000		4500	55,500		
City Cost Index (Sav. GA)			0%	0	0%	0	0	MMp533	MMp533
Subtotal				51000		4500	55,500		
OH & Profit Markups			0%	0	0%	0	0	MMp7	MMp475
Subtotal				51000		4500	55,500		
Sales Taxes			0.0%	0		NA	0	MMp476	
Total Construction Cost				51000		4500	55,500		
Design Fee				NA	0.0%	0	0		
SIOH				NA	0.0%	0	0		
Subtotal				51000		4500	55,500		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				51000		4500	$55,500		

LEGEND:
Vendor Price quote from telephone conversation with vendor.

RS&H®

Telephone Call Confirmation

Project Number 694 1331 002

Local ______ (L.D.) 800·327·2871 (Placed) B. Todd Rec'd ______ Date 2-6-96

Conversed with Tom McGee Of Fluid Conservation Systems Cincinnati, OH

Regarding Purchase of leak locating equipment

The leak locator is called a correlator, and includes two sensors with transmitters. The model C-2000 is about 10 years old. The new models are:

MicroCorr Cub	(made in UK)	$35,000	low end
Tri Corr-2001	(made in USA)	$51,000	high end

Correlator has receiver; input pipe diameter, type and distance between valve contact locations; usually locates the leak within inches and it is uncovered on the first dig.

They also sell a survey tool that is hand held and can be used to identify and find the general area of the leak. The cost of the survey tool is about $3,600.

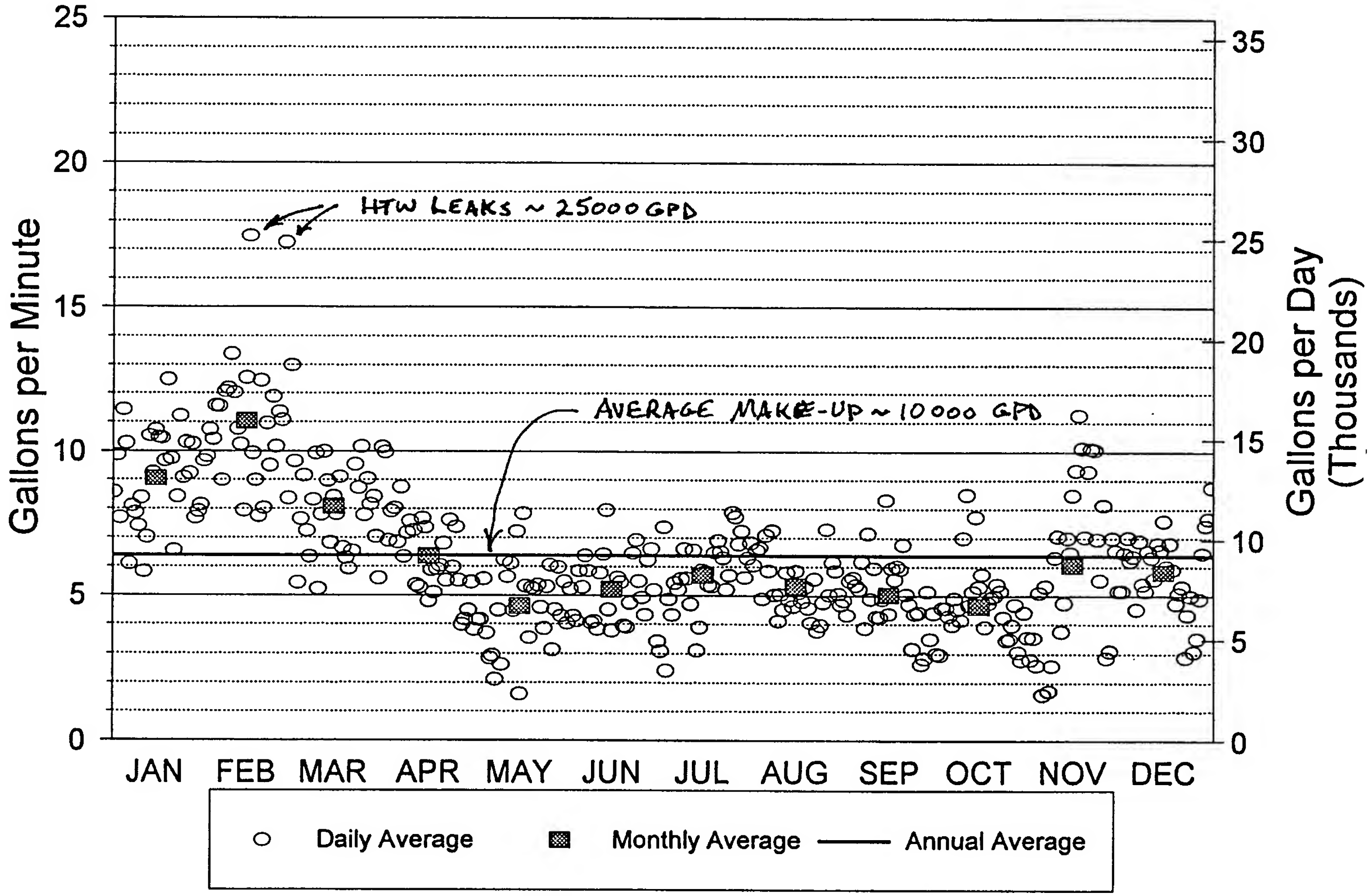
They offer a training course that includes on site class room and field work for 4½ days; cost ~ $4,500

~~Distribution:~~

Tom also recommended Consumers Applied Technologies out of Orlando to do leak detection work. Contact Keith Nelson at 407·382·0995. He is also familar with USA group.

Figure 4.1-5

Fort Stewart HTW Make-up Water, 1995



SITE WORK

022 200 | Excav./Backfill/Compact.

	No.	Description	Crew	Daily Output	Labor-Hours	Unit	1996 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P
204	0500	Air tamp, add (A12.3-110)	B-9	190	.211	C.Y.		4.25	.80	5.05	7.70
	0600	Vibrating plate, add	A-1	60	.133			2.64	1	3.64	5.30
	0800	Compaction in 12" layers, hand tamp, add to above	1 Clab	34	.235			4.66		4.66	7.45
	0900	Roller compaction operator walking, add	B-10A	150	.080			1.90	.57	2.47	3.58
	1000	Air tamp, add	B-9	285	.140			2.84	.53	3.37	5.10
	1100	Vibrating plate, add	A-1	90	.089			1.76	.67	2.43	3.55
	1300	Dozer backfilling, bulk, up to 300' haul, no compaction	B-10B	1,200	.010			.24	.71	.95	1.15
	1400	Air tamped	B-11B	240	.067			1.52	4.46	5.98	7.30
	1600	Compacting backfill, 6" to 12" lifts, vibrating roller	B-10C	800	.015			.36	1.19	1.55	1.86
	1700	Sheepsfoot roller	B-10D	750	.016			.38	1.29	1.67	2.01
	1900	Dozer backfilling, trench, up to 300' haul, no compaction	B-10B	900	.013			.32	.95	1.27	1.53
	2000	Air tamped	B-11B	235	.068			1.55	4.56	6.11	7.40
	2200	Compacting backfill, 6" to 12" lifts, vibrating roller	B-10C	700	.017			.41	1.37	1.78	2.13
	2300	Sheepsfoot roller	B-10D	650	.018			.44	1.49	1.93	2.32
234	0010	**DRILLING AND BLASTING** Only, rock, open face, under 1500 C.Y.	B-47	225	.107	C.Y.	1.50	2.36	2.52	6.38	8.15
	0100	Over 1500 C.Y.	"	300	.080		1.50	1.77	1.89	5.16	6.50
	2200	Trenches, up to 1500 C.Y.	B-47	22	1.091		4.50	24	25.50	54	71.50
	2300	Over 1500 C.Y.	"	26	.923		4.29	20.50	22	46.79	60.50
250	0010	**EXCAVATING, STRUCTURAL** Hand, pits to 6' deep, sandy soil	1 Clab	8	1	C.Y.		19.80		19.80	31.50
	0100	Heavy soil or clay		4	2			39.50		39.50	63
	0300	Pits 6' to 12' deep, sandy soil		5	1.600			31.50		31.50	50.50
	0500	Heavy soil or clay		3	2.667			53		53	84.50
	0700	Pits 12' to 18' deep, sandy soil		4	2			39.50		39.50	63
	0900	Heavy soil or clay		2	4			79		79	126
	1500	For wet or muck hand excavation, add to above				%				50%	50%
254	0010	**EXCAVATING, TRENCH** or continuous footing, common earth (A12.3-110)									
	0020	No sheeting or dewatering included									
	0050	1' to 4' deep, 3/8 C.Y. tractor loader/backhoe	B-11C	150	.107	C.Y.		2.43	1.39	3.82	5.30
	0060	1/2 C.Y. tractor loader/backhoe	B-11M	200	.080			1.82	1.43	3.25	4.41
	0090	4' to 6' deep, 1/2 C.Y. tractor loader/backhoe	"	200	.080			1.82	1.43	3.25	4.41
	0100	5/8 C.Y. hydraulic backhoe	B-12Q	250	.064			1.56	1.58	3.14	4.12
	0110	3/4 C.Y. hydraulic backhoe	B-12F	300	.053			1.30	1.50	2.80	3.64
	0300	1/2 C.Y. hydraulic excavator, truck mounted	B-12J	200	.080			1.95	3.15	5.10	6.45
	0500	6' to 10' deep, 3/4 C.Y. hydraulic backhoe	B-12F	225	.071			1.73	2	3.73	4.86
	0600	1 C.Y. hydraulic excavator, truck mounted	B-12K	400	.040			.97	2.17	3.14	3.88
	0900	10' to 14' deep, 3/4 C.Y. hydraulic backhoe	B-12F	200	.080			1.95	2.25	4.20	5.45
	1000	1-1/2 C.Y. hydraulic backhoe	B-12B	540	.030			.72	1.32	2.04	2.56
	1300	14' to 20' deep, 1 C.Y. hydraulic backhoe	B-12A	320	.050			1.22	1.72	2.94	3.77
	1400	By hand with pick and shovel to 6' deep, light soil	1 Clab	8	1			19.80		19.80	31.50
	1500	Heavy soil	"	4	2			39.50		39.50	63
	1700	For tamping backfilled trenches, air tamp, add	A-1	100	.080			1.58	.60	2.18	3.19
	1900	Vibrating plate, add		90	.089			1.76	.67	2.43	3.55
	2100	Trim sides and bottom for concrete pours, common earth		600	.013	S.F.		.26	.10	.36	.53
	2300	Hardpan		180	.044	"		.88	.33	1.21	1.77
258	0010	**EXCAVATING, UTILITY TRENCH** Common earth									
	0050	Trenching with chain trencher, 12 H.P., operator walking									
	0100	4" wide trench, 12" deep	B-53	800	.010	L.F.		.25	.11	.36	.50
	0150	18" deep		750	.011			.26	.11	.37	.52
	0200	24" deep		700	.011			.28	.12	.40	.56
	0300	6" wide trench, 12" deep		650	.012			.30	.13	.43	.61
	0350	18" deep		600	.013			.33	.14	.47	.66
	0400	24" deep		550	.015			.36	.15	.51	.72
	0450	36" deep		450	.018			.44	.19	.63	.88
	0600	8" wide trench, 12" deep		475	.017			.42	.18	.60	.84

A.3.11-16

FCS

FLUID CONSERVATION SYSTEMS

TriCorr 2001

Leak Correlator

The TriCorr 2001 is an advanced, portable microprocessor system for pinpointing fluid leaks in pressurized pipe systems.

It is the most advanced correlator on the market but is simple to operate and can be easily used by a single operator.

FCS specially designed the TriCorr 2001 for public and private water utilities, industrial and commercial water systems, engineering and service firms, and utility contractors.

Typical Configuration

❶ Correlator console with rechargeable battery
❷ Two remote preamplifiers/radio links
❸ Two high sensitivity sensors
❹ 110 VAC battery charger
❺ Stereo headphones
❻ Cassette training tapes
❼ Protective soft cases
12 VDC power cord/charger (not shown)
Operations manual (not shown)

Additional Equipment

Sensor mounting kit
Hydrophones
Hydrophone attachment kit
Cable reels
Measuring wheel
Survey instrument
Pipe locator
Printer
Cassette recorder/player

Size/Weight

Length:	14 inches
Depth:	6 inches
Width:	13 inches
Weight:	14.5 lbs. (including soft cases and battery)

Power Supply

10V 2.5AH Battery

Warranty

12 months parts and labor

Specifications subject to change.

A.3.11-18

Features: Benefits

Tri-Correlation: simultaneous display of three correlation graphs simplifies evaluation of correlation results

Peak Suppression: eliminates interference on correlation graph

Fast Fourier Transform (F.F.T.) Filtering: provides real-time analysis and increased signal resolution

True Signal Display: provides real-time, visual leak signal verification

Signal-to-Noise Display: provides numerical and visual representation of correlation peaks

Signal Spectrum Display: focuses user toward potential leak frequencies via bar graph

Velocity Calculation: allows for accurate correlation if pipe material or diameter is unknown

Multiple Pipe Type Diversity: can correlate on up to 7 different pipe materials or diameters within the selected span

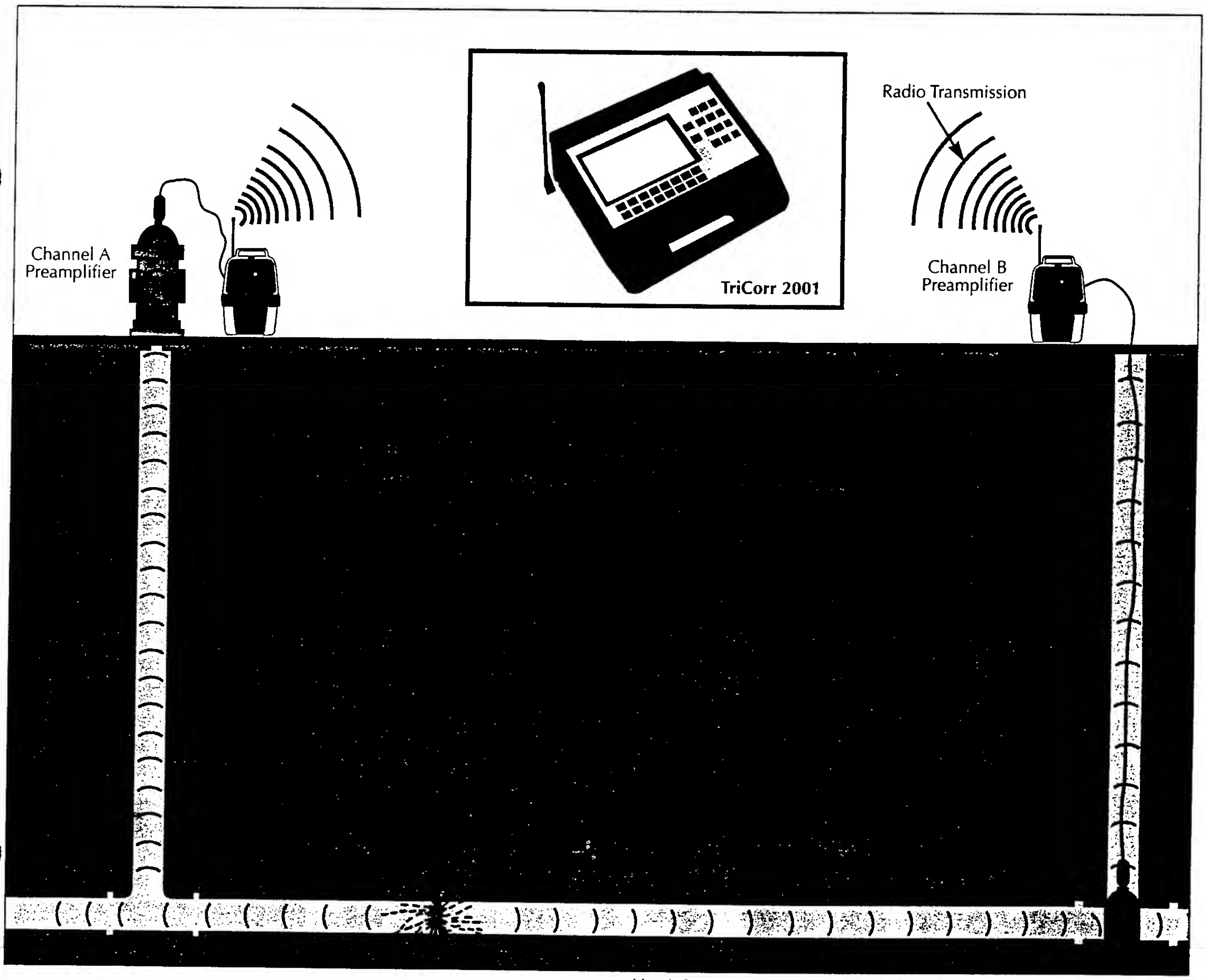
Trial Correlation: saves time/effort of correlating in insufficient leak signal situations

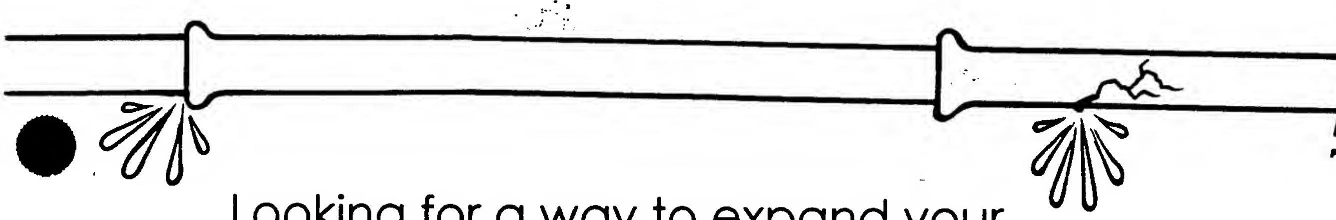
Rugged Construction: durable and effective in all field environments

Easy-to-use Software: easily used by all levels of personnel

Large High Visibility LCD: easy to read and interpret results

Large Button/Water-Resistant Keypad: can be used with gloves and in inclement weather





FCS

FLUID CONSERVATION SYSTEMS

Looking for a way to expand your leak detection program? Upgrading equipment?

Customize your own deal by choosing one of these three great options:

Purchase the TriCorr 2001 Leak Correlator at $51,500 and receive **FREE**:

- ***1 S20 Leak Survey Tool***
- ***4.5-Day Training Course***
- ***1 Additional Year Warranty***

...save $10,400!

Purchase the TriCorr 2001 Leak Correlator at $51,500 and receive **FREE**:

- **3 Aqualogs** for unmanned leak detection, and
- **1 laptop computer** for downloading the data.

...save $16,570

2

Or...***TRADE IT!***

We'll take **your** leak correlator (any make) as a trade-in, and give you $8,585 towards the purchase of a brand new TriCorr 2001 system!

...save $8,585

3

Call our sales department now at 800-531-5465 for information on this ***limited time offer!***

offer expires 3/30/96

--The Water Accountability Specialists--
Fluid Conservation Systems Inc.
2001 Ford Circle Suite F
Milford, Ohio 45150
(800) 531-5465 (513) 831-9336 fax

HALMA GROUP COMPANY

A.3.11-20

progress quickly and easily through the logical software programme, using the inbuilt push button keypad, to obtain fast accurate results.

The central unit of rigid polyurethane construction is easily portable, weighing only $3^1/_2$ kg. Correlation results are displayed on the high contrast liquid crystal display, which is backlit for night time or poor visibility operation.

Filter and velocity settings are automatically allocated dependent on pipe type, diameter and other data entered. There is the option of manual filter choice, aided by audio monitoring using the studio quality headphones provided. Where pipe data is not available, velocity can be quickly and easily measured to ensure accuracy of results.

For a pipe run of mixed materials or diameter, the mixed material function allows data for different pipe sections to be entered. The system automatically compensates and chooses velocity and filter settings accordingly.

The zoom function reduces resolution errors by allowing detailed examination of specific sections of the correlator graphic. Results can be stored for later examination or printed on the portable thermal printer (available as an accessory).

• MICROCORR CUB TECHNICAL SPECIFICATION •

MicroCorr® Unit

Frequency response	37-5000 Hz
Filters: high pass	37,75,150,300,600 Hz
low pass	310,625,1250,2500,5000 Hz
Max time delay	1550 ms
Max theoretical range	2.1km (iron pipe) 750m (pvc pipe)
Resolution	+\-0.1m
Display type	Backlit LCD
Battery supply	12v lead acid
Battery life	15 hours
Mixed materials	3 sections
Printer	RS232 interface
Memory	66 correlations
Construction	Rigid polyurethane
Dimensions	330 x 230 x 145mm
Weight	3.65kg

Features

Battery level indication
Auto shutdown
Survey mode
Velocity measurement
Auto gain
Signal level display
Context related help
Language options
Download to PC
Real time clock/display

Transmitter Unit

Transmitter range	2000m
Level indication	Meter
Battery type	12v lead acid 2.3 Ah
Battery level indication	Test switch
Battery life	8 hours typical
Weight	2.2kg
Dimensions	140 x 165 x 300mm
Case construction	Rigid polyurethane

Features

Top mounted controls
Auto gain
Interchangeable battery

PALMER ENVIRONMENTAL
Ty Coch House, Llantarnam Park Way, Cwmbran, Gwent NP44 3AW, United Kingdom
Telephone (01633) 489479 Int +44 1633 489479
Telefax (01633) 877857 Int +44 1633 877857

A.3.11-21

A HALMA GROUP COMPANY
TDA/4324/9.95/MP/1k

ECO NUMBER 12

REDUCE BOILER AND HTW SYSTEM OPERATING PRESSURE

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO-12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION A
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 0.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 0.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 0.
****** No investment costs; Other items should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	30244.	$ 40527.	14.88	$ 603041.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		30244.	$ 40527.		$ 603041.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 40527.

5. SIMPLE PAYBACK PERIOD (1G/4) .00 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 603041.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 26657.			
B. SIOH	$ 1600.			
C. DESIGN COST	$ 1600.			
D. TOTAL COST (1A+1B+1C)	$ 29857.			
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.		
F. PUBLIC UTILITY COMPANY REBATE		$ 0.		
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 29857.	

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	53115.	$ 71174.	14.88	$ 1059071.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		53115.	$ 71174.		$ 1059071.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 71174.

5. SIMPLE PAYBACK PERIOD (1G/4) .42 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 1059071.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 35.47
(IF < 1 PROJECT DOES NOT QUALIFY)

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-12
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION C
ANALYSIS DATE: 08-14-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$ 26657.		
B. SIOH	$ 1600.		
C. DESIGN COST	$ 1600.		
D. TOTAL COST (1A+1B+1C)	$ 29857.		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$ 0.	
F. PUBLIC UTILITY COMPANY REBATE		$ 0.	
G. TOTAL INVESTMENT (1D - 1E - 1F)			$ 29857.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	-26100.	$ -114840.	18.57	$ -2132579.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	110082.	$ 147510.	14.88	$ 2194947.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		83982.	$ 32670.		$ 62369.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -24600.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -366048.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -366048.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE))$ 8070.

5. SIMPLE PAYBACK PERIOD (1G/4) 3.70 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -303680.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= -10.17
(IF < 1 PROJECT DOES NOT QUALIFY)

 9/96

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WITH ECO-12A

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO-12X
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID FY95 (92)
INSTALLATION & LOCATION: FORT STEWART REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: ECO-12 REDUCE BOILER AND HTW SYSTEM PRESSURE
FISCAL YEAR 1995 DISCRETE PORTION NAME: OPTION B
ANALYSIS DATE: 02-15-96 ECONOMIC LIFE 20 YEARS PREPARED BY: W. TODD

1. INVESTMENT
A. CONSTRUCTION COST $ 26657.
B. SIOH $ 1600.
C. DESIGN COST $ 1600.
D. TOTAL COST (1A+1B+1C) $ 29857.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 29857.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1994

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 13.74	0.	$ 0.	15.08	$ 0.
B. DIST	$ 4.40	0.	$ 0.	18.57	$ 0.
C. RESID	$ .00	0.	$ 0.	21.02	$ 0.
D. NAT G	$ .00	0.	$ 0.	18.58	$ 0.
E. COAL	$ .00	0.	$ 0.	16.83	$ 0.
F. PPG	$ .00	0.	$ 0.	17.38	$ 0.
L. OTHER	$ 1.34	22871.	$ 30647.	14.88	$ 456029.
M. DEMAND SAVINGS			$ 0.	14.88	$ 0.
N. TOTAL		22871.	$ 30647.		$ 456029.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.88
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 30647.

5. SIMPLE PAYBACK PERIOD (1G/4) .97 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 456029.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 15.27
(IF < 1 PROJECT DOES NOT QUALIFY)

RS&H	SUBJECT: FORT STEWART / REDUCE OPERATING PRESSURE	AEP NO: 694 1331 002	
	DESIGNER: G. Fallon	SHEET: 1	OF:
	CHECKER:	DATE: 2-13-96	DATE:

ECO-12 REDUCE HTW PRESSURE

OPTION A. REDUCE PRESSURE FROM 180 TO 100 PSIG

SATURATION TEMPERATURE FOR 180 PSIG = 379°F

" " " 100 " = 338°F

TOTAL LINEAL FT OF PIPE = 121737 FT

LINEAL HEAT LOSS GOOD PIPE = 55 BTU/FT (see attached)

" " " BAD PIPE = 275 BTU/FT (" ")

ASSUME 1/2 OF THE PIPE IS GOOD & 1/2 IS BAD.

SEP LINEAL FT OF PIPE = 17500 FT

ENERGY SAVED IN HTW DISTRIBUTION SYSTEM

$$q_{CEP} = \frac{\left(1 - \frac{(338-60)}{(379-60)}\right) \times (121737 - 17500)\,ft \times \frac{(275+55)}{2}\,BTU/HR \cdot FT \times 8760\,H/yr}{1E6\ BTU/MBTU}$$

$= 19{,}364$ MBTU/yr

$$Q_{sep} = \left(1 - \frac{(338-60)}{(379-60)}\right) \times 17500\ ft \times \frac{275-55}{2}\,BTU/HR \cdot FT \times 135\,D/yr \times 24\,H/D$$

$= 1202$ MBTU/yr

$$Q_{TOT} = \frac{q_{CEP} + Q_{SEP}}{0.68}$$

NOTE: ASSUME 68% BOILER EFF.

$$= \frac{(19364 + 1202)\ MBTU/yr}{0.68} = \frac{20566}{0.68}\ MBtu/YR$$

$$= \boxed{30{,}244\ MBTU/yr}$$

NOTE: THIS OPTION CAN BE IMPLEMENTED IMMEDIATELY BY RESETTING THE CEP STEAM PRESSURE MASTER CONTROL SET POINT TO 100 PSIG.

ANNUAL SAVINGS

$\$ = 30{,}244$ MBTU/yr $\times$ 1.34 \$/MBTU

$= 40{,}527$ \$/yr

RS&H

SUBJECT	FORT STEWART	AEP NO	694 1331 002
	REDUCE OP. PRESSURE	SHEET	2 OF
DESIGNER	G. Fallon	DATE	2-13-96
CHECKER		DATE	

ECO 12 CONT. REDUCE HTW PRESSURE

OPTION B: REDUCE PRESSURE TO 60 psig

SATURATION TEMPERATURE FOR 60psig = 307 °F

NOTE: 60psig WAS CHOSEN BECAUSE THE AUTOCLAVES IN THE HOSPITAL REQUIRE 50-80 psig STEAM.

ENERGY SAVED IN DISTRIBUTION SYSTEM

$$Q_{CEP} = \frac{\left(1-\frac{(307-60)}{(379-60)}\right) \times (121737-17500)\,ft \times \frac{(275+55)}{2}\,BTU/hr \cdot ft \times 8760\ HR/yr}{1E6\ BTU/MBTU}$$

$$= 34{,}006\ MBTU/yr.$$

$$Q_{SEP} = \frac{\left(1-\frac{(307-60)}{(379-60)}\right) \times (17500)\,ft \times \frac{(275+55)}{2}\,BTU/HR \cdot FT \times 135\ D/yr \times 24\ H/D}{1E6\ BTU/MBTU}$$

$$= 2112\ MBTU/yr.$$

$$Q_{TOT} = \frac{Q_{CEP} + Q_{SEP}}{0.68}$$

$$= \frac{(34006 + 2112)}{0.68}\ MBTU/yr$$

$$= \boxed{53{,}115\ MBTU/yr}$$

ANNUAL COST SAVINGS

SAVINGS = 53,115 MBTU/yr × 1.34 \$/MBTU

= 71,174 \$/yr

RS&H

SUBJECT FORT STEWART
Reduce Op. Pressure
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET 3 OF
DATE 2-13-96
DATE

ECO 12 CONT. REDUCE HTW PRESSURE

OPTION B (CONTINUED)

THE BOILER PRESSURE MUST REMAIN AT APPROXIMATELY 100 PSIG TO SUPPLY ITS OWN SOOT BLOWING PRESSURE.

A PRESSURE REDUCING STATION MUST BE PROVIDED TO REDUCE THE STEAM PRESSURE FROM 100 PSIG TO 60 PSIG. THE PRESSURE REDUCING STATION INCLUDES:

1 PRV W/ PNEUMATIC ACTUATOR
1 PRESSURE TRANSMITTER
1 PRESSURE CONTROLLER W/SET POINT ADJUSTMENT.

INSTALLATION COST

SEE ESTIMATE SHEET.

RS&H

SUBJECT FORT STEWART
Reduce Op. Pressure
DESIGNER G. Fallon
CHECKER

AEP NO 694 1331 002
SHEET 4 OF
DATE 2-13-96
DATE

ECO 12 CONT.. REDUCE HTW PRESSURE

OPTION C: REDUCE PRESSURE TO 30 psig. THE STEAM KETTLES IN THE DINING FACILITIES OPERATE ON 30 psig STEAM. AN ALTERNATE HEATING TECHNIQUE WILL HAVE TO BE INSTALLED IN THE HOSPITAL TO SUPPLY THE AUTOCLAVES.

ENERGY SAVED IN DISTRIBUTION SYSTEM

$$Q_{CEP} = \frac{\left(1-\frac{(274-60)}{(379-60)}\right) \times (121737-17500)\,ft \times \frac{(275+55)}{2}\,BTU/ft\,Hr \times 8760\,Hr/yr}{1E6\ BTU/mBTU}$$

$$= 49{,}592.\ mBTU/yr$$

$$Q_{SEP} = \frac{\left(1-\frac{(274-60)}{(379-60)}\right) \times (17500)\,ft \times \frac{(275+55)}{2}\,BTU/ft\,HR \times 135\ D/y \times 24\ H/D}{1E6\ BTU/mBTU}$$

$$= 3079\ mBTU/yr$$

$$Q_{TOT} = Q_{CEP} + Q_{SEP}$$

$$= \frac{(49{,}592+3079)\ mBTU/yr}{0.68}$$

$$= \underline{77{,}457\ mBTU/yr}$$

ANNUAL COST SAVINGS FROM DISTRIBUTION SYSTEM

$$SAVINGS = 77457\ mBTU/yr \times 1.34\ \$/mBTU$$

$$= 103{,}793\ \$/yr.$$

ENERGY REQUIRED IN HOSPITAL

ASSUME 5 AUTOCLAVES @ 60 psig, 1000 #/HR, 12 H/D 365 D/yr 85% BOILER EFF.

RS&H

SUBJECT: FORT STEWART
Reduce Op. Pressure
DESIGNER: G. Fallon
CHECKER:

AEP NO: 694 1331 002
SHEET: 5 OF
DATE: 2-13-96
DATE:

ECO-12 CONT. REDUCE HTW PRESSURE

OPTION C: (CONTINUED)

$$Q = \frac{5 \times 1000\ \#/HR \times (1181 - (200-32)) \times 4380\ HR/YR}{0.85 \times 1E6\ B/mB} = \frac{22185\ mBtu/YR}{0.85}$$

$$= \underline{26{,}100}\ mBTU/yr \text{ Additional Fuel Oil}$$

ANNUAL COST

$$COST = 26100\ mBTU/yr \times (4.40 - 1.34/0.68)\ \$/mBTU$$

$$= \$63{,}408/yr$$

TOTAL ENERGY SAVINGS (INCREASE)

$$HTG.\ FUEL = 77457\ mBTU/yr + \frac{22185}{0.68}\ mBtu/YR = \boxed{110082\ \frac{mBtu}{YR}}$$

$$FUEL\ OIL = \boxed{(26{,}100)\ mBTU/yr.}$$

NET COST SAVINGS

$$S_c = \$103{,}793/yr - \$63{,}408/yr.$$

$$= \$40385/yr$$

RS&H

SUBJECT Fort Stewart HTW
Boiler O+M Costs
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 8-13-96
DATE

HOSPITAL BOILER O&M COSTS:

IF THE HOSPITAL BOILERS ARE OPERATED, THEY WILL REQUIRE AN OPERATOR / MAINTENANCE PERSON TO TEND AND REPAIR THEM. ASSUME THE TIME REQUIRED FOR O&M AVERAGES ABOUT $1\frac{1}{2}$ HOUR PER SHIFT, 365 DAYS PER YEAR.

$$\text{O\&M TIME} = 1.5\ \text{HR/SHIFT} \times 3\ \text{SHIFT/DAY} \times 365\ \text{DAY/YR} \approx 1640\ \text{HR/YR}$$

USING A RATE OF \$15 PER HOUR, THE ANNUAL O&M COSTS ARE:

$$\text{O\&M \$} = 1640\ \text{HR/YR} \times \$15/\text{HR} = \underline{\$24{,}600/\text{YR}}$$

CURRENT PIPING ENERGY LOSS

$Q_{CEP} = (121737 - 17500)\,ft \times (275+55)/2 \ BTU/HR \cdot ft \times 8760$

$104237 \times 165 \times 8760$

$= 150{,}664 \ mBTU/yr$

$Q_{SEP} = (17500)\,ft \times (275+55)/2 \ BTU/HR \cdot ft \times 135 \times 24$

$= 9355 \ mBTU/yr$

$Q_{TOT} = 150{,}664 \ mBtu/YR + 9355 \ mBtu/YR = 160019 \ mBtu/YR$

Current fuel use $= 160{,}019 \frac{mBtu}{YR} \div 0.68 = \underline{235{,}322 \frac{mBtu}{YR}}$

RS&H

SUBJECT	FORT STEWART	AEP NO	694-1331-002
		SHEET	OF
DESIGNER	W.T. TODD	DATE	2-19-96
CHECKER		DATE	

OPERATE HTW SYSTEM AT LOWER PRESSURES

AFFECT ON OTHER ECO'S

OP. PRESSURE	HTW TEMP.	ΔT (1)	HEAT LOSS (2)
180 PSIG	380 °F	310 °F	258.7 $\frac{\text{MBtu}}{\text{YR}}$
100 PSIG	238 °F	268 °F	223.6 $\frac{\text{MBtu}}{\text{YR}}$
60 PSIG	307 °F	237 °F	197.8 $\frac{\text{MBtu}}{\text{YR}}$

(1) Based on HTW make-up water temperature of 70 °F.
(2) See spreadsheet calculations on following 3 pages. Loss is for fictitious loss of 100,000 Gal/year.

All ECO's that reduce the HTW losses will be affected by operation at lower pressures. The energy savings for these ECO's will be reduced by the following amounts:

180 PSIG → 100 PSIG :

$$\% \text{ Change} = \frac{257.8 - 223.6}{257.8} \Rightarrow \underline{13.57\ \%}$$

100 PSIG → 60 PSIG :

$$\% \text{ Change} = \frac{223.6 - 197.8}{223.6} \Rightarrow \underline{11.54\ \%}$$

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	Existing Conditions	Date:	02/19/96
ECO Number:	All		

Assumptions:

1. HTW temperature	380	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings)	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 310 °F = 258.7 MBtu/Yr

Heating Fuel Use = 258.7 MBtu/yr / 0.68 = 380.4 MBtu/Yr

Heating Fuel Cost = 380.4 MBtu/yr x $1.34 /MBtu = $510 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$BHP = \frac{0.19 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.02 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x $0.0469 /kWh = $7 /Year

Water Cost:

100000 Gal/Yr x $0.5562 /kGal = $56 /Year

Total Utility Cost Savings:

Heating Fuel Cost	$510	/Year
Pumping (Elec) Cost	$7	/Year
Water Cost	$56	/Year
Total Savings	$573	/Year

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	With ECO-12 Option A	Date:	02/19/96
ECO Number:	All		

Assumptions:

1. HTW temperature	338	°F
2. Make-up water temperature	70	°F
3. Boiler efficiency	68%	
4. Pump head (from record drawings)	300	Ft H20
5. Pump efficiency (from record drawings)	72%	
6. Motor efficiency	90%	
7. Average heating fuel cost	$1.34	/MBtu
8. Electricity cost	$0.0469	/kWh
9. Water cost	$0.5562	/kGallons

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 268 °F = 223.6 MBtu/Yr

Heating Fuel Use = 223.6 MBtu/yr / 0.68 = 328.9 MBtu/Yr

Heating Fuel Cost = 328.9 MBtu/yr x $1.34 /MBtu = $441 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.19 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.02 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x $0.0469 /kWh = $7 /Year

Water Cost:

100000 Gal/Yr x $0.5562 /kGal = $56 /Year

Total Utility Cost Savings:

Heating Fuel Cost	$441	/Year
Pumping (Elec) Cost	$7	/Year
Water Cost	$56	/Year
Total Savings	$504	/Year

Location:	Fort Stewart, GA	Reynolds, Smith and Hills, Inc.	
AEP Number:	694-1331-002	Designer:	W. T. Todd
Project:	With ECO-12 Option B	Date:	02/19/96
ECO Number:	All		

Assumptions:

1.	HTW temperature	307	°F
2.	Make-up water temperature	70	°F
3.	Boiler efficiency	68%	
4.	Pump head (from record drawings)	300	Ft H20
5.	Pump efficiency (from record drawings)	72%	
6.	Motor efficiency	90%	
7.	Average heating fuel cost	$1.34	/MBtu
8.	Electricity cost	$0.0469	/kWh
9.	Water cost	$0.5562	/kGallons

Energy Loss Calculations:

Energy Use = flow rate x specific heat x temperature difference

100000 Gal/Yr x 8.345 lb/gal x 1 Btu/lb°F x 237 °F = 197.8 MBtu/Yr

Heating Fuel Use = 197.8 MBtu/yr / 0.68 = 290.8 MBtu/Yr

Heating Fuel Cost = 290.8 MBtu/yr x $1.34 /MBtu = $390 /Year

Pumping Cost:

Pump BHP = (GPM x Feet Head) / (3960 x Pump Efficiency)

$$\text{BHP} = \frac{0.19 \text{ GPM} \times 300 \text{ Ft Head}}{3960 \times 0.72} = 0.02 \text{ BHP}$$

Energy Use = (BHP / Motor Efficiency) x 0.746 kW/HP x 8760 Hr/Yr

Electric Demand = 0.02 BHP / 0.90 x 0.746 kW/HP = 0.02 kW

Electricity Use = 0.02 kW x 8760 Hr/Yr = 145 kWh/Yr

Electricity Cost = 145 kWh/Yr x $0.0469 /kWh = $7 /Year

Water Cost:

100000 Gal/Yr x $0.5562 /kGal = $56 /Year

Total Utility Cost Savings:

Heating Fuel Cost	$390	/Year
Pumping (Elec) Cost	$7	/Year
Water Cost	$56	/Year
Total Savings	$453	/Year

CONSTRUCTION COST ESTIMATE

Project:	Reduce Operating Pressure	RS&H No.:	694-1331-002
Location:	Fort Stewart, GA	Date:	02/14/96
Basis:	Schematic Design	Estimator:	G.W. Fallon
ECO No.:	12	Filename:	EST-12.WQ1

ITEM DESCRIPTION	QUANTITY		MATERIAL/EQUIP		LABOR		TOTAL COST	SOURCE	
	No.	Unit	$/Unit	Total	$/Unit	Total		Material	Labor
Pressure Reducing Station, w/ controls	1	ea	22233	22233	305	305	22,538	Vendor	MMp192
300 lb flange, 10" dia Weld Neck	2	ea	220	440	145.5	291	731	MMp165	MMp165
Welding Labor	2	ea	0	0	123.15	246	246		MMp144
Subtotal Bare Costs				22673		842	$23,515		
Retrofit Cost Factors			0%	0	0%	0	0	MMp6	MMp6
Subtotal				22673		842	23,515		
City Cost Index (Sav. GA)			0%	0	-44%	-372	(372)	MMp533	MMp533
Subtotal				22673		470	23,143		
OH & Profit Markups			10%	2267	53%	249	2,516	MMp7	MMp475
Subtotal				24940		719	25,659		
Sales Taxes			4.0%	998		NA	998	MMp476	
Total Construction Cost				25938		719	26,657		
Design Fee				NA	6.0%	1599	1,599		
SIOH				NA	6.0%	1599	1,599		
Subtotal				25938		3917	29,855		
Contingency			0%	0	0%	0	0	MEp6	MEp6
Total Project Cost				25938		3917	$29,855		

LEGEND:

Vendor Telephone/fax quote from manufacturers rep.

MMp### 1996 Means Mechanical Cost Data, page ###.

FISHER-ROSEMOUNT

Key Controls Inc.
Jacksonville Branch
1409 Kingsley Ave. Suite 7B
Orange Park, Florida 32073-4532
Tel 1 (904) 269-5455
Fax 1 (904) 269-5446

February 13, 1996

Reynolds, Smith & Hills Inc.
4651 Salisbury Rd.
Jacksonville, FL 32216

Attn: George Fowler

RE: Budgetary Proposal Steam Pressure Control Valve; Key Controls' Quotation #96-32080

Dear Mr. Fowler:

Thank you for your inquiry. As per your conversations with Wes King, we are pleased to quote budgetary pricing on the following Fisher Controls' products.

Item 1 Qty. 1

8" x 6" Fisher Type EWD globe control valve. ANSI Class 300# carbon steel body, 416 SST seat ring, 17-4PH SST plug, 416 SST Whisper III cage. Operated by a Fisher Type 471-16, size 60, pneumatic double-acting piston actuator, and Fisher Type 3570 pneumatic valve positioner. 60 psig actuator supply. 3-15 psig positioner input. Increasing signal to open. An external fail-safe device would be required to achieve failure for this valve. Also includes Fisher Type 4195KB, proportional-plus reset pneumatic controller. 300 psig bourdon tube element. With 2" pipestand mounting.

UNIT PRICE = $ 22,233.30
ESTIMATED DELIVERY = 10-12 WKS ARO

Pricing for this estimate is firm for 30 days from today's date, and is quote FOB shipping point, with surface freight allowed to jobsite.

Please find enclosed a control valve specification sheet, detailing valve construction and selected service conditions. If you have any further questions, please contact Tom Glaspie or Wes King at your convenience.

Sincerely yours,

Wesley A. King

Wes King

Fisher Controls

Control Valve Specification

FISHER®

Customer: G. Fowler
Reference: Fort Stewart
Order No: —
Quote No:
Date 2/13/96 Page 1 of 1

Item		1
Quantity		1
Application		Steam Press. Control
Tag		
Size and Type		8" x 6" 470-16-EWD
Body	Style	☒ Globe ☐ Angle ☐
Body	End Connections	☐ Scrd ☐ SWE ☒ Flg 300 ANSI RF ☐ BWE Schedule Casting Rating ☐
Body	Material	☐ Iron ☐ 316 SST ☒ Steel ☐
Body	Number of Ports	☒ One ☐ Two
Body	Push Down to	☒ Close ☐ Open
Body	Flow Direction	☐ Down ☒ Up
Trim	Trim Number	301
Trim	Cage or Retainer Material	416SS Whisper III
Trim	Bushing Material	
Trim	Seat Ring Material	416SS
Trim	Valve Plug Material	17-4 ph SS
Trim	Valve Plug Guiding	☒ Cage ☐ Top ☐ Stem ☐ Port ☐ Top & Bottom
Trim	Valve Plug Balance	☒ Balanced ☐ Unbalanced
Trim	Port Size	☐ Full ☒ 5 3/8"
Trim	Characteristic	☐ Quick-Opening ☒ Linear ☐ Equal-Percentage ☐
Trim	Shutoff Class	☒ Standard ☐
Bonnet	Style	☒ Std ☐ Ext. #
Bonnet	Boss Size	☒ Std ☐
Bonnet	Packing	☒ TFE ☐ Lubr & Isol Valve ☐ TFE Asb ☐ ☐ Lam Graphite
Bonnet	Bolting Bonnet	☒ Std ☐
Bonnet	Bolting Pack. Flg.	☒ Std ☐
Actuator	Style	☒ Piston ☐ Diaph ☐
Actuator	Size	60
Actuator	Air to Actuator	☐ 3 to 15 ☐ 6 to 30 ☒ 60
Actuator	Air Fails Valve to	☐ Close ☐ Open ☐ Lock
Actuator	Handjack	☐ Top ☐ Side

Positioner	Type	☐ 3582 ☐ 3590 ☒ 3570
Positioner	Input Signal	☒ 3 to 15 psi ☐ 4 to 20 mA ☐ 6 to 30 psi ☐ 10 to 50 mA ☐ ☐
Positioner	Accessories	☒ Airset ☒ Gauges ☐ Bypass
Positioner	Increase Signal Valve	☐ Closes ☒ Opens
I/P Positioner Only	Certification†	☐ None
I/P Positioner Only	Explosion-proof	☐ CSA
I/P Positioner Only	Intrinsically safe	☐ FM ☐ CSA
Controller	Type	4195KB
Controller	Action	☒ Direct ☐ Reverse
Controller	Measuring Element	☒ Bourdon Tube ☐ Bellows Range 360 Psig ☐ Bronze ☐ Steel ☒ SST
Controller	Output (Psig)	☒ 3 to 15 ☐ 6 to 30 ☐
Controller	Mounting	☐ Yoke ☐ Csg ☒ Remote
Controller	Airset	☒ 67AFR-221 ☐
Controller	Airset Mounting	☐ Yoke ☒ Nipple
546 Transducer	Input Signal (mA)	☐ 10 to 50 ☐ 4 to 20 ☐
546 Transducer	Output Signal (Psig)	☐ 3 to 15 ☐ 6 to 30 ☐
546 Transducer	Action	☐ Direct ☐ Reverse
546 Transducer	Mounting	☐ Yoke ☐ Csg ☐ Pipe
546 Transducer	Airset	☐ 67AFR-362 ☐
546 Transducer	Certification†	☐ None
546 Transducer	Explosion-proof	☐ FM ☐ CSA
546 Transducer	Intrinsically safe	☒ FM ☐ CSA

Service Conditions

☒ Throttling ☐ On-Off ☐ PRV ☐ Relief

	1	2	3
Flowing Media	Sat. Steam		
Specific Gravity			
Inlet Temperature °F		400	
Inlet Pressure (Psig)	100	100	200
Inlet Vapor Pressure			
ΔP Sizing (Psi)	85	40	140
ΔP Shutoff (Psi)		200	
Flow Rate, Give Units #/hr	100,000	100,000	100,000
Req'd Flow Coeff., ☐ C_v ☒ C_g ☐ C_s	13,146	15,181	9,695
Valve Coefficient		15,500	
Recovery Coeff., ☐ K_m ☒ C_1		33.7	
Noise Level (dBA)	99.6	92.9	87.2
Line Size (in.)		8" STD	

Worksheet

Notes and/or Special Constructions

PREPARED BY: WK
DATE: 2/13/96
KEY CONTROLS INC.
1409 KINGSLEY AVE.
ORANGE PARK, FL 32073

Approximate Shipping Weight, Lb.	List Price	$
	Unit Net Price	$
	Total Net Price	$

† Please insure proper certification requirements of barrier interface before entering order. See Hazardous Area Certifications Bulletin 9.2:001.

Form 2881D

CONF-8406132--2

ANALYSIS OF A SMALL DISTRICT STEAM SYSTEM AT FT. McCLELLAN, ALABAMA

CONF-8406132
DE84 014051

Gerald D. Pine and Michael A. Karnitz

Energy Division
Oak Ridge National Laboratory*
Oak Ridge, Tennessee 37831

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For presentation at the
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MASTER

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A.3.12-21

Of the total steam produced, we estimate that approximately 95% enters the steam distribution system. The remaining 5% is used within the boiler plants to power auxiliaries. This amounts to some 570 lb/hr on the average or 5.0 million lb/yr. Then approximately 96 million lb/yr enters the distribution system.

5. CAUSES FOR HEAT LOSS FROM BURIED PIPE

In order to minimize heat losses from steam and condensate pipe lines, the lines are usually insulated. Sometimes the pipes may run above ground but more commonly, the pipes are buried from two to six feet below the surface. If the insulation is intact and dry, the ground helps to insulate the pipe from cold temperatures in the winter and to reduce the heat losses. In this section, we present estimates of the heat losses for well insulated pipes as well as for pipes with deteriorated insulation and under various failure conditions.

Heat Loss From Dry, Insulated, Buried Pipes. Heat losses have been calculated for varied soil conditions and various types of insulation by King et. al. [3]. For the example of a six-inch steam line at 325°F with four inches of calcium silicate insulation in clay of average moisture and a soil temperature of 50°F, the rate of heat loss would be approximately 55 Btu/hour per linear foot of pipe. For the Ft. McClellan system with a steam temperature of 338°F and a ground temperature of 80°F, the loss rate would be about 52 Btu/hr-ft.

Heat Loss From Bare Pipes in Air. The simplest case to consider is a bare pipe exposed to ambient air on a dry, still day. For this case, the two major heat loss mechanisms are natural convection and radiation. We consider the case of a six-inch pipe with 338°F steam and ambient air at 150°F (a typical temperature inside a dry vault, where much of the bare pipe is found). The estimated loss due to natural convection under these conditions is about 350 Btu/hour per foot of pipe. Kreith [4] in Table 5.1 gives a value of emissivity of 0.8 for oxidized steel pipe. For the same pipe, the estimated radiation loss is approximately 570 Btu/hr-ft. The total loss per foot of bare pipe under these circumstances is then 920 Btu/hr-ft.

Buried Pipes With Entrapped Moisture and Deteriorated Insulation. Observations of actual buried steam lines indicates that the heat losses are substantially higher than the theoretical losses. Consideration of the magnitudes of the observed losses suggests that the pipe is behaving as though there were no insulation, and that the pipe is in direct contact with the surrounding soil. The most likely physical explanation is that the conductivity has been greatly enhanced by the deterioration of the insulation from the combined effects of heat and moisture that gets into the system by steam leaks or the intrusion of ground water. Entrapped moisture could be boiling near the surface of the pipe and condensing on the jacket, or subcooled boiling and the formation of a thermal convection loop in water filling the space between the pipe and jacket could be occurring. Both these processes produce extremely high heat transfer rates compared to the rate through dry insulation. If it is assumed that the conductivity of the insulation is infinite, the model of King et al. yields a heat transfer factor of about 1.8 Btu/hr-°F per foot of six-inch diameter pipe. For the six-inch pipe at 338°F and a 80°F ground temperature, the rate of heat loss per foot of pipe would be 460 Btu/hr-ft. This compares with the observed value of about 275 Btu/hr-ft.

Heat Loss From Flooding of Vaults. A commonly observed failure of steam lines is the failure of sump pumps in valve pits and the subsequent covering of the steam pipe with water. The source of the water can be either condensate from steam traps, which collects in the vault and causes flooding when sump pumps fail, or intrusion of ground water into the pits through cracks in the pit wall or around pipes that penetrate the pit walls. Water in the vaults is commonly heated to temperatures that are rather hot; we assume here that the water in the vault is heated to 150°F. The estimated rate of heat loss from a bare, six-inch steam pipe carrying 338°F steam and covered by 150°F water is 50,000 Btu/hr-ft. (This estimate could be higher, perhaps as high as 150,000 Btu/hr-ft depending on the assumed heat transfer mechanism.) Notice that the loss is nearly sixty times as large as the loss from dry, bare pipe. Perhaps even more interesting, the rate of heat loss would be 190 times greater than the

A.4 HTW LOSS CALCULATIONS

Fort Stewart - Measured/Estimated HTW Leaks
Filename: F-MAKEUP.WB2

WATER LOSS ESTIMATE		
ITEM	GPD	GPM
1) Boiler & Cascade Blowdown	1440	1.00
2) Sootblowing - Boiler No. 4	468	0.33
3) CEP - Miscellaneous Leaks	302	0.21
4) CEP - No. 4 Boiler Pipe & Fitting	323	0.22
5) SEP - Miscellaneous Leaks	336	0.23
6) Valve Pit Leaks - Valves & Fitting	1398	0.97
7) Mechanical Equip. Room Leaks	1260	0.88
8) Heating Equip./SEP Losses (1)	1034	0.72
9) SEP Start-up Losses (1)	158	0.11
10) Repaired HTW Piping Leaks (1)	55	0.04
Subtotal Identified Losses (2)	**6774**	**4.71**
Average 1995 Make-up Water Use	9173	6.37
- Total Losses Identified	6774	4.71
Estimated HTW Piping Leaks (3)	**2399**	**1.66**
(1) Losses obtained from the HTW make-up data, could not be visually verified during survey. (2) Some leaks may have been repaired or new leaks may have formed since the survey. (3) Other leaks include HVAC equipment, hot water generators, equipment repair, etc.		

PIE CHART VALUES

Blowdown & Soot Blowing	1908	1.33	21%
CEP/SEP/VP/ME Rm Leaks	3619	2.51	39%
Other Identified Losses	1247	0.87	14%
HTW Piping Leaks	2399	1.66	26%
			100%

BAR CHART VALUES

	1993	1994	1995
Blowdown & Soot Blowing	1908	1908	1908
Valve & Equip. Leaks	3619	3619	3619
Other Losses	1247	1247	1247
HTW Piping Leaks	6072	7682	2399

Test Procedure

Objective

To determine the hot water system leaks external to the Steam Plant

System Description

The hot water heating and distribution system consists of three gas/oil fired package boilers, one stoker fired wood boiler, three (3) cascade water heaters and circulating pumps. Boiler steam is condensed in the cascade heaters warming the water. The hot water is circulated facility wide in an underground distribution system supplying the heat for various needs including domestic hot water heating for kitchen, bathroom and laundry use, steam for cooking. Space heating is also provided during the winter months. Closed heat exchangers at each use point remove heat from the water. The slightly cooled water is returned to the steam plant for re-heating. The hot water distribution and return system is a closed system. With all valves closed any required make-up water would be due to leaks.

The heated water from the cascade heaters is used for boiler feedwater. The known system loses are the result of steam soot blowing (primarily on the wood fired boiler) and boiler blowdown along with scattered steam leaks typical of such a facility.

Procedure

Fill the system (no. 1 heater) to the desired level. Note the time and the make-up water totalizer reading. Operate the facility normally for 8 hours, except:

- do not operate the steam soot blowers.
- do not blow down the boilers.
- do not blow down the heaters.
- do not deliberately allow water or steam losses from any source.

Keep the power plant as "tight" as possible. Keep heater water levels within acceptable limits. Near the end of the 8 hour period fill the heaters to the starting level, record the time and the makeup water totalizer reading.

Results

The amount of make-up water used during the test should be theoretically equal the total system loses during the test. Since the system losses in the steam plant are minimized, the make-up water consumed is equal to system leaks outside the steam plant.

Leak Test Results

The results of the enclosed leak test procedure yielded a loss of 1787 gallons in an 8 hour period (223 gal/hr, 3.72 gpm, 5361 gpd). This loss was attributed to hot water distribution system leaks outside of the steam plant. Summing these losses with those from sootblowing and blowdown estimates above yields a daily make-up flow of 6045 gallons (5361+468+216). More importantly, however the losses from sootblowing and boiler blow down are shown to be a small part (11.3%) of the total system losses.

CALCULATE % LOSSES

Fort Stewart – Central Energy Plant
Estimate of HTW System Losses
Filename: F-HTW-CP.WQ1

Pipe Service	Bldg. Served	Pipe Dia. (in)	Linear Ft w/loops	Pipe Vol. (CF)	Pipe Vol. (Gal)
ZONE 1					
HTWS	All (main)	8	1485	518.4	3880
HTWR	All (main)	8	1485	518.4	3880
HTWS	All (main)	8	2200	767.9	5750
HTWR	All (main)	8	2200	767.9	5750
HTWS	All (main)	6	220	43.2	320
HTWR	All (main)	6	220	43.2	320
HTWS	All (main)	6	2035	399.6	2990
HTWR	All (main)	6	2035	399.6	2990
HTWS	All (main)	6	825	162.0	1210
HTWR	All (main)	6	825	162.0	1210
HTWS	All (main)	4	825	72.0	540
HTWR	All (main)	4	825	72.0	540
HTWS	All (main)	2	880	19.2	140
HTWR	All (main)	2	880	19.2	140
HTWS	All (main)	5	385	52.5	390
HTWR	All (main)	5	385	52.5	390
HTWS	All (main)	4	880	76.8	570
HTWR	All (main)	4	880	76.8	570
HTWS	All (main)	2.5	440	15.0	110
HTWR	All (main)	2.5	440	15.0	110
Branch Piping (assume 5% of mains)					1590
Bldgs	72	1	100	0.5	290
SUBTOTAL ZONE 1			20350		33680
ZONE 2					
HTWS	All (main)	6	4070	799.1	5980
HTWR	All (main)	6	4070	799.1	5980
HTWS	All (main)	5	1375	187.5	1400
HTWR	All (main)	5	1375	187.5	1400
HTWS	All (main)	4	550	48.0	360
HTWR	All (main)	4	550	48.0	360
HTWS	All (main)	2	4510	98.4	740
HTWR	All (main)	2	4510	98.4	740
HTWS	All (main)	1.5	330	4.0	30
HTWR	All (main)	1.5	330	4.0	30
HTWS	All (main)	2.5	550	18.7	140
HTWR	All (main)	2.5	550	18.7	140
HTWS	All (main)	2.25	990	27.3	200
HTWR	All (main)	2.25	990	27.3	200
HTWS	All (main)	1.25	1980	16.9	130
HTWR	All (main)	1.25	1980	16.9	130
HTWS	All (main)	2	770	16.8	130
HTWR	All (main)	2	770	16.8	130
Branch Piping (assume 5% of mains)					910
Bldgs	34	1	100	0.5	140
SUBTOTAL ZONE 2			30250		19270

CALCULATE % LOSSES

Fort Stewart – Central Energy Plant
Estimate of HTW System Losses
Filename: F–HTW–CP.WQ1

ZONE 3					
HTWS	All (main)	10	5225	2849.8	21320
HTWR	All (main)	10	5225	2849.8	21320
HTWS	All (main)	10	3850	2099.8	15710
HTWR	All (main)	10	3850	2099.8	15710
HTWS	All (main)	6	1980	388.8	2910
HTWR	All (main)	6	1980	388.8	2910
HTWS	All (main)	5	990	135.0	1010
HTWR	All (main)	5	990	135.0	1010
HTWS	All (main)	8	605	211.2	1580
HTWR	All (main)	8	605	211.2	1580
HTWS	All (main)	6	605	118.8	890
HTWR	All (main)	6	605	118.8	890
HTWS	All (main)	4	1100	96.0	720
HTWR	All (main)	4	1100	96.0	720
HTWS	All (main)	2	880	19.2	140
HTWR	All (main)	2	880	19.2	140
HTWS	All (main)	4	1650	144.0	1080
HTWR	All (main)	4	1650	144.0	1080
Branch Piping (assume 5% of mains)					4540
Bldgs	27	1	100	0.5	110
SUBTOTAL ZONE 3			33770		95370
SEP ZONE					
HTWR	All (main)	4	5390	470.4	3520
HTWR	All (main)	2	5390	117.6	880
STMS	All (main)	10	5390	2939.8	150
HTWS	All (main)	8	440	153.6	1150
HTWR	All (main)	8	440	153.6	1150
HTWS	All (main)	4	2860	249.6	1870
HTWR	All (main)	4	2860	249.6	1870
HTWS	All (main)	3	880	43.2	320
HTWR	All (main)	3	880	43.2	320
HTWS	All (main)	2.5	1760	60.0	450
HTWR	All (main)	2.5	1760	60.0	450
HTWS	All (main)	2	770	16.8	130
HTWR	All (main)	2	770	16.8	130
HTWS	All (main)	2	990	21.6	160
HTWR	All (main)	2	990	21.6	160
Branch Piping (assume 5% of mains)					640
Bldgs	5	1	100	0.5	20
SUBTOTAL SEP ZONE			31570		13370
Cascade Htrs, Expansion Tanks, etc., estimated					14500
Total Estimated System Volume					176190 Gallons

CALCULATE % LOSSES

Fort Stewart - Central Energy Plant
Estimate of HTW System Losses
Filename: F-HTW-CP.WQ1

CALCULATION OF PERCENT HTW LOSSES

Typical Closed Loop Piping Systems

0.5% of total volume lost per day =	881 Gal/Day
881 gal/day x 30.4 day/mo =	26796 Gal/Mo.
881 gpd / 1440 min/day =	0.61 Gal/Min

Fort Stewart HTW Piping System

2203 gal/day x 30.4 day/mo =	67014 Gal/Mo.
2203 gpd / 1440 min/day =	1.53 Gal/Min
Percent of total volume lost per day =	1.3%

Blowdown

Blowing down the boiler is required to control the boiler water chemistry. Excessive blowdown is wasteful. Insufficient blowdown can severely damage the boiler pressure parts over time. Generally, the boilers should be blown down as little as possible while keeping the boiler water chemistry under control. The blowdown procedures should be reviewed. Blowing down the lower headers every shift is generally regarded as excessive.

The American Boiler Manufacturers Association recommends that boilers operating below 300 psig should have less than 3500 ppm total solids, less than 700 ppm total Alkalinity, and less than 300 ppm total suspended solids. If the boiler water concentrations of these parameters are substantially below these values, then perhaps the boilers are being blown down too much.

The lower header blowdown valves are 1-1/2" diameter, but are connected to 3/4" diameter pipe from the valves to the blowdown tank. The 3/4" pipe controls the flow from the boiler's lower headers when the blowdown valves are wide open. Assuming an equivalent of 100 feet of pipe from the valves to the blow down tank yields a flow rate of 48 gpm. A ten second blow from each of the three lower headers would actually take 30 seconds each (10 seconds to open the valve , ten seconds to blow, and ten seconds to close the valve) yielding a consumption of 24 gallons per blow. With three lower headers and three blows per day per header, 216 gal. per day are discharged requiring an equivalent amount of make-up.

BOILER & CASCADE HEATER BLOWDOWN

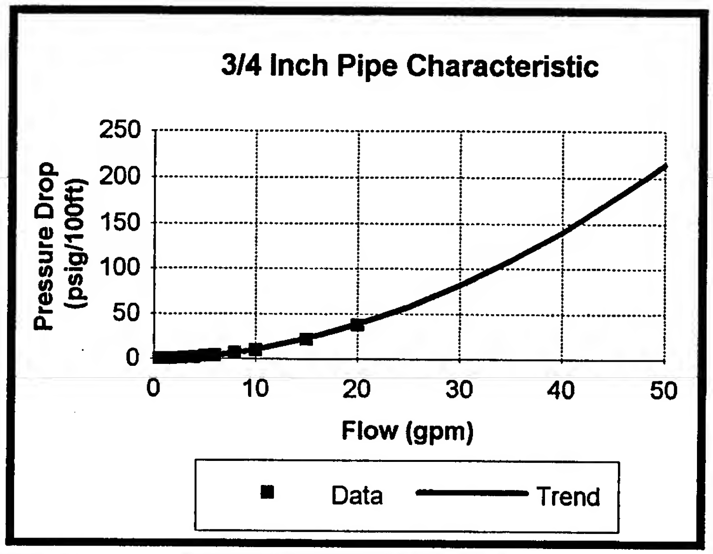
Table 4.2-1 ESTIMATED WATER LOSS DUE TO BLOWDOWN

Blowdown Point	Duration Est. (min)		Pipe Dia.	Pipe Length	Pres. Drop	Flow			Average
	Est. #1	Est. #2	(in)	(ft)	(ft)	(gpm)	(gpd, #1)	(gpd, #2)	(gpd)
Intermittent (1)									
Heater #1	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
Heater #2	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
Heater #3	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
No. 4 Boiler									
East Wall	0.33	0.50	1	100	400	87.5	29.2	43.8	
West Wall	0.33	0.50	1	100	400	87.5	29.2	43.8	
Rear Wall	0.33	0.50	1	100	400	87.5	29.2	43.8	
East Drum	0.33	0.50	1	100	400	87.5	29.2	43.8	
West Drum	0.33	0.50	1	100	400	87.5	29.2	43.8	
Sub-total Intermittent Blowdown - Summer							448	343	395
Heater #4	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
Heater #5	0.42	0.17	1	100	400	87.5	36.5	14.6	
Level Xmtr.	0.20	0.08	1	10	400	320.9	64.2	26.7	
Additional Intermittent Blowdown - Winter							201	83	142
Continuous (2)									
Steam Drum	1440	0	1/16	100	400	1.353	1948	0	974
Total Blowdown - Summer							2396	343	1369
Total Blowdown - Winter							2597	425	1511

(1) Assumes 200 psi, 1 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.
(2) Assumes 200 psi, 1/16 inch orifice, square edged, C=0.82; Cameron Hydraulic Data, pages 2-8 and 2-9.

BOILER & CASCADE HEATER BLOWDOWN

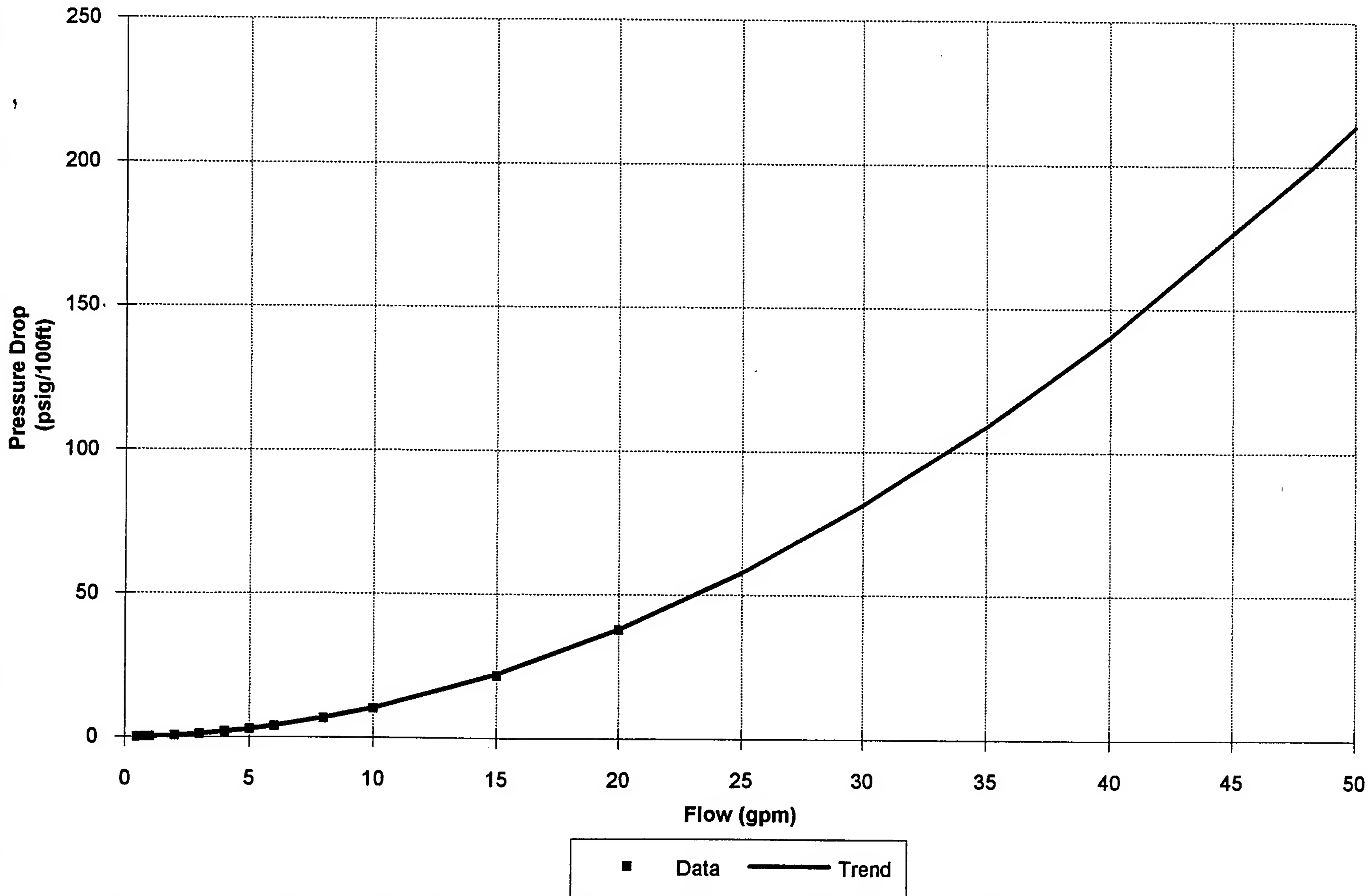
				1.886	-2.01536	6.59603	0.133273			
0.5	0.033	-0.6931	-3.41	0.036						
0.6	0.041	-0.5108	-3.19	0.051						
0.8	0.102	-0.2231	-2.28	0.087						
1	0.155	0	-1.86	0.133						
2	0.526	0.69315	-0.64	0.493						
3	1.09	1.09861	0.086	1.059						
4	1.83	1.38629	0.604	1.822						
5	2.75	1.60944	1.012	2.775						
6	3.84	1.79176	1.345	3.915						
8	6.6	2.07944	1.887	6.736						
10	9.99	2.30259	2.302	10.261						
15	21.6	2.70805	3.073	22.050						
20	37.8	2.99573	3.632	37.940						
25	57.7975907			57.798						
30	81.52346277			81.523						
35				109.037						
40				140.273						
48.275				200.000						
50				213.694						
FLOW (GPM)	TIME (SEC/SHIFT)	BLOW POINTS	SHIFT /DAY		GAL/DAY	GPM				
48	30	3	3		216	0.150				
LBS/CY	GAL/CY	LOWER	CY/SH	SH/D						
325	39.0	2	2	3	468	0.325				
					684	0.475				
5.63	3.72									
5.63	4.20									
8100	6045									



BOILER & CASCADE HEATER BLOWDOWN

FIGURE 2

3/4 Inch Pipe Characteristic



STEWMU.XLS Chart 11

10/12/95

FLOW THROUGH ORIFICES AND NOZZLES

Approximate discharge through orifice or nozzle.

$$Q = 19.636\, C d_1^2 \sqrt{h} \sqrt{\frac{1}{1 - \left(\frac{d_1}{d_2}\right)^4}} \text{ where } \frac{d_1}{d_2} \text{ is greater than } 0.3$$

$$Q = 19.636\, C d_1^2 \sqrt{h} \text{ where } \frac{d_1}{d_2} \text{ is less than } 0.3$$

Q = flow, in gpm
d_1 = dia of orifice or nozzle opening, inches
h = differential head at orifice, in feet of liquid.
d_2 = dia of pipe in which orifice is placed, inches
C = discharge coefficient (typical values below for water)

RE-ENTRANT TUBE	SHARP-EDGED	SQUARE EDGED	RE-ENTRANT TUBE	SQUARE EDGED	WELL ROUNDED
C = .52	C = .61	C = .61	C = .73	C = .82	C = .98

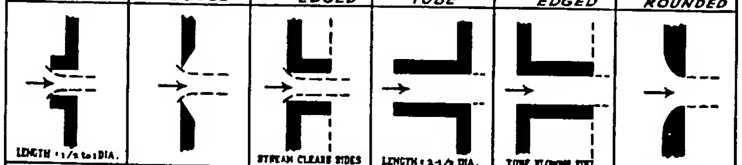


Table on next page shows flow using a value of C = 1.00. These flows values may be multiplied by the C value for a particular discharge to obtain actual flow.

Approximate flow through Venturi tube.

$$Q = 19.05\, d_1^2 \sqrt{H} \sqrt{\frac{1}{1 - \left(\frac{d_1}{d_2}\right)^4}} \text{ for any Venturi tube}$$

$$Q = 19.17\, d_1^2 \sqrt{H} \text{ for a Venturi tube in which } d_1 = 1/3\, d_2$$

Q = flow, in gpm
d_1 = dia. of venturi throat, inches
d_2 = dia. of main pipe, inches
H = diff. in head between upstream end and throat (ft.)

These formulas are suitable for any liquid with viscosities similar to water. The values given here are for water. A value of 32.174 ft. per sec^2 was used for the acceleration of gravity and a value of 7.48 gal. per cu ft in computing the constants.

A.4-11

BOILER & CASCADE HEATER BLOWDOWN

Flow Data—Nozzles

Theoretical Discharge of Nozzles in U S Gallons Per Minute

Head* psi	Head* feet**	Velocity of disch ft/sec	1/16	1/8	3/16	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8
10	23.1	38.6	0.37	1.48	3.32	5.91	13.3	23.6	36.9	53.1	72.4	94.5	120	148	179
15	34.6	47.25	0.45	1.81	4.06	7.24	16.3	28.9	45.2	65.0	88.5	116.	147	181	219
20	46.2	54.55	0.52	2.09	4.69	8.35	18.8	33.4	52.2	75.1	102.	134.	169	209	253
25	57.7	61.0	0.58	2.34	5.25	9.34	21.0	37.3	58.3	84.0	114.	149.	189	234	283
30	69.3	66.85	0.64	2.56	5.75	10.2	23.0	40.9	63.9	92.0	125.	164.	207	256	309
35	80.8	72.2	0.69	2.77	6.21	11.1	24.8	44.2	69.0	99.5	135.	177.	224	277	334
40	92.4	77.2	0.74	2.96	6.64	11.8	26.6	47.3	73.8	106.	145.	188.	239	296	357
45	103.9	81.8	0.78	3.13	7.03	12.5	28.2	50.1	78.2	113.	153.	200.	253	313	379
50	115.5	86.25	0.83	3.30	7.41	13.2	29.7	52.8	82.5	119.	162.	211.	267	330	399
55	127.0	90.5	0.87	3.46	7.77	13.8	31.1	55.3	86.4	125.	169.	221.	280	346	418
60	138.6	94.5	0.90	3.62	8.12	14.5	32.5	57.8	90.4	130.	177.	231.	293	362	438
65	150.1	98.3	0.94	3.77	8.45	15.1	33.8	60.2	94.0	136.	184.	241.	305	376	455
70	161.7	102.1	0.98	3.91	8.78	15.7	35.2	62.5	97.7	141.	191.	250.	317	391	473
75	173.2	105.7	1.01	4.05	9.08	16.2	36.4	64.7	101.	146.	198.	259.	327	404	489
80	184.8	109.1	1.05	4.18	9.39	16.7	37.6	66.8	104.	150.	205.	267.	338	418	505
85	196.3	112.5	1.08	4.31	9.67	17.3	38.8	68.9	108.	155.	211.	276.	349	431	521
90	207.9	115.8	1.11	4.43	9.95	17.7	39.9	70.8	111.	160.	217.	284.	359	443	536
95	219.4	119.0	1.14	4.56	10.2	18.2	41.0	72.8	114.	164.	223.	292.	369	456	551
100	230.9	122.0	1.17	4.67	10.5	18.2	42.1	74.7	117.	168.	229.	299.	378	467	565
105	242.4	125.0	1.20	4.79	10.8	19.2	43.1	76.5	120.	172.	234.	306.	388	479	579
110	254.0	128.0	1.23	4.90	11.0	19.6	44.1	78.4	122.	176.	240.	314.	397	490	593
115	265.5	130.9	1.25	5.01	11.2	20.0	45.1	80.1	125.	180.	245.	320.	406	501	606
120	277.1	133.7	1.28	5.12	11.5	20.5	46.0	81.8	128.	184.	251.	327.	414	512	619
130	300.2	139.1	1.33	5.33	12.0	21.3	48.0	85.2	133.	192.	261.	341.	432	533	645
140	323.3	144.3	1.38	5.53	12.4	22.1	49.8	88.4	138.	199.	271.	354.	448	553	668
150	346.4	149.5	1.43	5.72	12.9	22.9	51.6	91.5	143.	206.	280.	366.	463	572	692
175	404.1	161.4	1.55	6.18	13.9	24.7	55.6	98.8	154.	222.	302.	395.	500	618	747
200	461.9	172.6	1.65	6.61	14.8	26.4	59.5	106.	165.	238.	323.	423.	535	660	799
250	577.4	193.0	1.85	7.39	16.6	29.6	66.5	118.	185.	266.	362.	473.	598	739	894
300	692.8	211.2	2.02	8.08	18.2	32.4	72.8	129.	202.	291.	396.	517.	655	808	977

			1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/2	4	4 1/2	5	5 1/2	6
10	23.1	38.6	213	289	378	479	591	714	851	1158	1510	1915	2365	2855	3405
15	34.6	47.25	260	354	463	585	723	874	1041	1418	1850	2345	2890	3490	4165
20	46.2	54.55	301	409	535	676	835	1009	1203	1638	2135	2710	3340	4040	4810
25	57.7	61.0	336	458	598	756	934	1128	1345	1830	2385	3025	3730	4510	5380
30	69.3	66.85	368	501	655	828	1023	1236	1473	2005	2615	3315	4090	4940	5895
35	80.8	72.2	398	541	708	895	1106	1335	1591	2168	2825	3580	4415	5340	6370
40	92.4	77.2	425	578	756	957	1182	1428	1701	2315	3020	3830	4725	5610	6810
45	103.9	81.8	451	613	801	1015	1252	1512	1802	2455	3200	4055	5000	6050	7120
50	115.5	86.25	475	647	845	1070	1320	1595	1900	2590	3375	4275	5280	6380	7600
55	127.0	90.4	498	678	886	1121	1385	1671	1991	2710	3540	4480	5530	6690	7970
60	138.6	94.5	521	708	926	1172	1447	1748	2085	2835	3700	4685	5790	6980	8330
65	150.1	98.3	542	737	964	1220	1506	1819	2165	2950	3850	4875	6020	7270	8670
70	161.7	102.1	563	765	1001	1267	1565	1888	2250	3065	4000	5060	6250	7560	9000
75	173.2	105.7	582	792	1037	1310	1619	1955	2330	3170	4135	5240	6475	7820	9320
80	184.8	109.1	602	818	1070	1354	1672	2020	2405	3280	4270	5410	6690	8080	9630
85	196.3	112.5	620	844	1103	1395	1723	2080	2480	3375	4400	5575	6890	8320	9920
90	207.9	115.8	638	868	1136	1436	1773	2140	2550	3475	4530	5740	7090	8560	10210
95	219.4	119.0	656	892	1168	1476	1824	2200	2625	3570	4655	5900	7290	8800	10500
100	230.9	122.0	672	915	1196	1512	1870	2255	2690	3660	4775	6050	7470	9030	10770
105	242.4	125.0	689	937	1226	1550	1916	2312	2755	3750	4890	6200	7650	9260	11020
110	254.0	128.0	705	960	1255	1588	1961	2366	2820	3840	5010	6340	7840	9470	11300
115	265.5	130.9	720	980	1282	1621	2005	2420	2885	3930	5120	6490	8010	9680	11550
120	277.1	133.7	736	1002	1310	1659	2050	2470	2945	4015	5225	6630	8180	9900	11800
130	300.2	139.1	767	1043	1365	1726	2132	2575	3070	4175	5450	6900	8530	10300	12290
140	323.3	144.3	795	1082	1415	1790	2212	2650	3180	4330	5650	7160	8850	10690	12730
150	346.4	149.5	824	1120	1466	1853	2290	2760	3295	4485	5850	7410	9150	11070	13200
175	404.1	161.4	890	1210	1582	2000	2473	2985	3560	4840	6310	8000	9890	11940	14250
200	461.9	172.6	950	1294	1691	2140	2645	3190	3800	5175	6760	8550	10580	12770	15220
250	577.4	193.0	1063	1447	1891	2392	2955	3570	4250	5795	7550	9570	11820	14290	17020
300	692.8	211.2	1163	1582	2070	2615	3235	3900	4650	6330	8260	10480	12940	15620	18610

The actual quantity discharged by a nozzle will be less than above table. A well tapered smooth nozzle may be assumed to give 97 to 99% of the values in the tables.

* Where there is both an upstream and downstream pressure, the head is a differential head.

** Head in feet basis water at approx. 60°F.

SOOTBLOWING LOSSES

Sootblowing

The sootblowing operations should be carefully reviewed. Blowing soot twice per shift regardless of need is not proper procedure. Blowing too frequently can cause excessive tube erosion perhaps resulting in premature tube replacement. Frequent blowing is also wasteful of valuable steam, particularly at reduced boiler loads.

Soot blowing should be initiated primarily by high exit gas temperature which indicates that the energy released by the fuel is not being absorbed by the dirty tube surfaces. A 40° rise in exit gas temperature is approximately equal to 1% in boiler efficiency. Often this rule of thumb is used to determine when the boiler has become fouled with the solid products of combustion and should be cleaned by operating the sootblowers. Unfortunately, there is no indication of exit gas temperature on the boiler.

A simple thermometer ($50) can be installed in the hot gas duct to the air heater to indicate the exit gas temperature. Operators can record the exit gas temperature hourly and activate the soot blowers when the exit gas temperature gets too high.

The Diamond Power factory calculates that 325 lb. steam (39 gals water) are consumed every time the IK sootblower is operated. With two IK blowers and 6 operations each per day the total steam consumption is 3900 lb. steam (468 gals) per day.

RS&H

SUBJECT	FORT STEWART / CEP Misc. Leaks	AEP NO	694 1331 002
		SHEET	1 OF 2
DESIGNER	W. Todd	DATE	2-2-96
CHECKER		DATE	

CEP MISCELLANEOUS LEAKS

Valves & Fittings:

	Leak Rate Estimate.
Cascade Heater No. 1	
- Valve to top of sight glass leaking steam	2 drop/sec
- Valve on top left of heater leaking steam	2 "
Cascade Heater No. 2	
- Valve on bottom left of heater leaking steam	2 "
Cascade Heater No. 3	
- Valve on top of sight glass leaking steam	2 "
Deaerator Tank	
- Strainer next to control valve leaking steam and about 3 drops/second HTW.	5 "
- Valve above stairs leaking steam	2 "
- Vent to outside blowing steam (intermittant)	2 "
Total values & fittings leaks	17 drops/sec

$$17 \text{ drops/second} \times 2.5\times10^{-3} \frac{\text{gpm}}{\text{d/s}} = \underline{0.042 \text{ gal/min}}$$

HTW Zone Pumps:

- P-4 & P-5 ~ 1drop/4 seconds = 0.0006 GPM
- P-10 ~ steady 1/8" stream * = 0.109 GPM
- P-11 ~ Intermittant 1/8" stream* = 0.054 GPM

RS&H

SUBJECT Fort Stewart
CEP Misc. Leaks
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET 2 OF 2
DATE 2-2-96
DATE

Pumps (continued)

- P-23 & P-24 ~ 2 drops/3 seconds = 0.0017 GPM

*A 1/8" stream was measured and timed and found to be ~1.75 cups/min ÷ 16 $\frac{\text{cups}}{\text{gal}}$ ≈ 0.109 GPM

Total leaks from HTW Pumps = 0.165 GPM

Total Miscellaneous CEP Leaks:

Valves & Fittings	0.042 GPM
HTW Zone Pumps	0.165 GPM
Total =	0.207 GPM

CEP - No. 4 HTW LEAKS

Central Energy Plant (CEP) Leak Test #4 Boiler

On November 30, 1995 a leak test was conducted at CEP to determine the extent of the leaks associated with Boiler No.4. A significant amount of steam continually vents from the No.4 blowdown tank. To quantify this loss, a CEP leak test would be conducted with the No.4 boiler configured in as a "tight" a mode as possible, and then a second test would be conducted with No.4 in a "normal" (leaky) configuration. The difference in the test results would be the leaks due to No. 4's normal configuration.

The leak test consists of measuring the make-up water required to maintain constant heater levels over an 8 hour period. Unfortunately, the test results showed no heater level changes over the 6 hour test period when a 6-7 inch change in the gauge glass level was expected. This testing technique has yielded results in the past. No explanation for the lack of results was determined; however, improper system valving is strongly suspected.

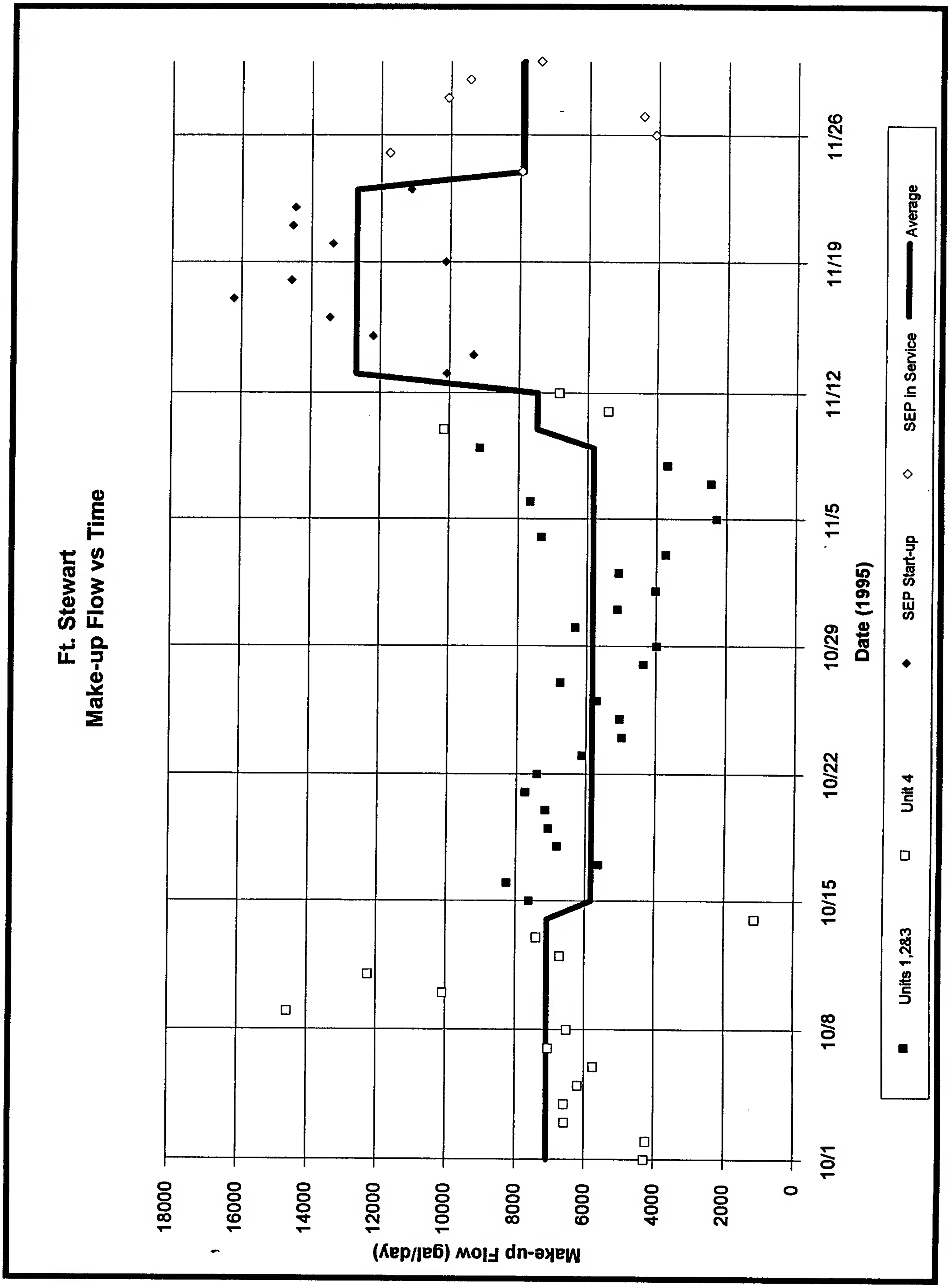
Configuring the boiler in as tight a configuration as possible stopped the blowdown tank steam venting. Leaking steam traps in the main steam line, the soot blower warm-up line, and in the boiler feed pump turbine line are the sources of the steam venting. Furthermore, the rear water wall header blowdown valves are leaking slightly. This leak was so small that only warm water entered the blow down tank.

A graph (enclosed) of the daily make-up consumption data shows a wide scattering of data, perhaps lending credence to the suspicion that observing heater tank levels over a short period of time (8 hours) yields uncertain results. However, when averaged over longer periods of time (weeks), yields more reliable results. The graph shows the daily make-up consumption (DMC) prior to October 15, 1995 averaged about 7000 gpd (4.86 gpm) while unit 4 alone was operating. During the period October 15 through November 10, 1995 unit 4 was shut down and units 1,2 and 3 were operating, and the DMC fell to 5900 gpd (4.10 gpm). This reduction in DMC can be attributed to two principal causes; 1) the general leaky state of unit No. 4; and 2) the required consumption of steam for sootblowing. The magnitude of the change 1100 gpd (0.764 gpm) seems reasonable. The fact that the consumption returned to the original levels when 4 boiler was returned to service implies that some of the leaks are in fact related to unit No. 4.

No. 4 Boiler Operation Recommendations

1. Repair steam trap leaks.
2. Reduce soot blowing frequency. Change from a time based operation to an exit gas temperature based operation.
3. Reduce blow down frequency to maintain American Boiler Manufacturers Association standard of 3500 ppm total dissolved solids.

CEP - No. 4 HTW LEAKS



Satellite Energy Plant (SEP) Leak test.

On November 29, 1995 the SEP was tested for system leaks. The testing procedure consists of stopping all steam flow to, and condensate return flow from, the SEP, and measuring the decrease in the level of the two cascade heaters in the SEP. By calculating the volume change in the heaters, a leak rate may be determined.

Time (EST)	9:46	10:34	11:13	11:37	11:48
Level (in)	14.3	14.3	14.3	14.3	14.3
Temp (°F)	375	360	340	335	330
Pres. (psig)	190	140	115	105	100

The data from the 2 hour test indicated that the water level in the heaters never changed while the circulating hot water showed a -45° temperature change and a -90 psig pressure change. It was concluded therefore the SEP system was "tight".

It is important to note however that the testing method used is quite crude over the short time period of the test. The two, 4000 gallon, cascade heaters are connected by symmetrical piping assuring "equal" water levels in both heaters. A one inch change in water level, at normal operating level, would be equivalent to 140 gallons of water. The leaks found and measured during the test are tabulated below.

Location	Amount (gpm)
East Heater gauge glass	2.23×10^{-4}
East Heater Steam Stop valve	2.11×10^{-3}
West Heater Equalization valve	1.00×10^{-3}
HTWS Check Valve	0.03
Both Heaters blow down valves	0.2
TOTAL	**0.233**

The total amount of water lost during the test is 0.233 gpm x 122 min. = 29 gals., or approximately 0.2 inches on the gauge glass. With normal, slow, level swings (generally attributable to sloshing) between the tanks, this leak rate is barley detectable in the sight glass over the time span of the test. Because of the large heater storage capacity, a longer test period is warranted. In the future this test could be a reasonable leak detection and quantification method at the SEP if conducted over longer testing periods. The best time for the test would be when the heat load from the SEP is minimal, perhaps on a warm day after a cool night.

VALVE PIT HTW LEAKS

RS&H

SUBJECT Fort Stewart
Repair Leaks in Valve Pits
DESIGNER W. Todd
CHECKER

AEP NO 694 1331 002
SHEET ____ OF ____
DATE 2-5-96
DATE

Valve Pit No.	Drops /Sec	Stream Dia./GPM	Leak From
VP-1-11	1/3	– –	Valve
VP-1-16	3+2	– –	↓
VP-2N-5	5+	– –	
VP-2S-1	2	– –	
VP-2S-3	2	– –	↓
VP-2S-8	2+2	– –	2 valves
VP-3-1	2	1/4" / 0.438	Flange
VP-3-5	1/10 + 2	– –	Valve
VP-3-11	–	1/8" / 0.109	"
VP-3-15	–	1/8" / 0.109	Flange
VP-3-16	–	3/16" / 0.246	↓
VP-3-18	2	– –	
VP-3-27	1+2	– –	↓
Totals 13 Pits	27.4 D/s	0.902 GPM	

Minor Leaks :

$$27.4 \ \text{drop/s} \times 2.5 \times 10^{-3} \ \frac{\text{GPM}}{\text{d/s}} = 0.069 \ \text{GPM} = 36{,}270 \ \frac{\text{GAL}}{\text{YR}}$$

Proposed HTW losses : Assume 50% of minor leaks

$$0.069 \ \text{GPM} \times 1440 \ \frac{\text{min}}{\text{day}} \times 365 \ \frac{\text{day}}{\text{YR}} \times 0.5 = \underline{18130 \ \frac{\text{GAL}}{\text{YR}}}$$

Major Leaks : (Assume 100% can be repaired)

$$0.902 \ \text{GPM} \times 1440 \ \text{min/day} \times 365 \ \text{day/YR} = 474{,}090 \ \text{GAL/YR}$$

Current HTW Losses :

$$474090 \ \text{GAL/YR} + 36270 \ \text{GAL/YR} = \underline{510{,}360 \ \text{GAL/YR}}$$

MECH. EQUIP. ROOM HTW LEAKS

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

Building No.	HTW Zone	Building Type	DHW Temp.	Water Sample	Mech Rm Survey	HTW Leaks	Other Leaks	HTW Drop/Sec	HTW Cup/Min
206	3	Learning Center	80	DHW	Y	Y	Y	2.00	0.33
207	3	Dining Facility	124	DHW	Y	N	N		
208	3	Fitness Center	113	DHW	Y	Y	N	0.06	
211	3	Admin.	N/A	N/A	Y	Y	N	4.00	
212	3	Admin/Barracks	131	DHW	Y	N	N		
213	3	Barracks	120	DHW	Y	N	N		
215	3	Barracks	137	DHW	Y	Y	N	2.00	1.50
216	3	Barracks	110	DHW	Y	Y	N	2.50	
217	3	Admin.	N/A	N/A	Y	Y	N	0.13	
218	3	Barracks	124	DHW	Y	N	Y		
223	3	Admin.	N/A	N/A	Y	Y	N	0.17	
224	3	Admin.	N/A	N/A	Y	Y	N	5.00	6.67
225	3	Admin.	N/A	N/A	Y	N	N		
230	3	Tac Equip Shop	N/A	N/A	Y	N	N		
241	3	Tac Equip Shop	N/A	N/A	Y	N	N		
260	3	Tac Equip Shop	N/A	N/A	Y	N	N		
270	3	Tac Equip Shop	N/A	N/A	Y	Y	N	2.20	
276	3	Tac Equip Shop	N/A	N/A	N				
302	3	Hospital	137	DHW	Y	N	N		
403	N/A	Child Care Ctr	N/A	N/A	Y	N/A	N		
439	N/A	Fitness Center	139	DHW	Y	N/A	N		
440	2	Dental Clinic	114	DHW	Y	N	N		
501	2	Barracks	134	DHW	Y	Y	N	0.33	
503	2	Barracks	122	DHW	Y	Y	N	2.00	0.25
504	2	Barracks	158	DHW	Y	Y	N		0.75
506	2	Admin.	N/A	N/A	Y	N	N		
507	2	Admin.	N/A	N/A	Y	Y	N	1.00	
508	2	Admin.	N/A	N/A	Y	N	N		
509	2	Admin.	N/A	N/A	Y	N	Y		
512	2	Dining Facility	145	DHW	Y	?	Y		1.17
514	2	Barracks	126	DHW	Y	Y	N	1.25	
515	2	Barracks	123	DHW	Y	N	Y		
516	2	Barracks	145	DHW	Y	?	Y		
517	2	Barracks	175	DHW	LOCKED				
518	2	Barracks	183	DHW	Y	?	Y	3.33	
520	2	Admin.	N/A	N/A	Y	N	Y		
521	2	Admin.	N/A	N/A	Y	Y	N	0.50	
522	2	Admin.	N/A	N/A	Y	Y	N	0.25	
523	2	Admin.	N/A	N/A	Y	N	N		
524	2	Admin.	N/A	N/A	Y	N	N		
525	2	Admin.	N/A	N/A	Y	Y	N	0.09	

10 Flanges
10 Valves

MECH. ROOM HTW LEAKS

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

Building No.	HTW Zone	Building Type	DHW Temp.	Water Sample	Mech Rm Survey	HTW Leaks	Other Leaks	HTW Drop/Sec	HTW Cup/Min	
608	2	Fitness Center	127	DHW	Y	Y	N	0.08		
610	2	Chapel	115	DHW	Y	N	N			
612	2	Admin.	N/A	N/A	Y	Y	Y	0.08		V
614	1	Admin.	N/A	N/A	Y	N	Y			
616	1	Admin.	N/A	N/A	Y	N	Y			
617	1	Admin.	N/A	N/A	Y	N	N			
618	1	Admin.	N/A	N/A	Y	N	N			
619	1	Admin.	N/A	N/A	Y	N	N			
620	1	Admin.	112	DHW	Y	N	N			
621	1	Admin.	91	DHW	Y	N	N			
622	1	Admin.	85	DHW	Y	N	N			
623	1	Admin.	109	DHW	Y	N	Y			
624	1	Admin.	109	DHW	Y	N	Y			
626	1	Dining Facility	145	DHW	Y	N	N			
628	1	Admin.	N/A	N/A	Y	Y	N	0.20		V
629	1	Barracks	160	DHW	Y	?	Y			
630	1	Barracks	117	DHW	Y	N	Y			
631	1	Barracks	142	DHW	Y	Y	Y		0.88	V+
632	1	Barracks	160	DHW	Y	N	Y			
633	1	Barracks	128	DHW	Y	Y	Y	2.00		F
634	1	Barracks	LOCKED	LOCKED	Y	N	N			
635	1	Barracks	140	DHW	Y	Y	N	1.59		F
636	1	Barracks	138	DHW	Y	Y	Y	1.22		V
637	1	Barracks	158	DHW	Y	N	N			
638	1	Admin.	N/A	N/A	Y	N	Y			
639	1	Admin.	N/A	N/A	Y	Y	N	1.56		V
640	1	Admin.	N/A	N/A	Y	N	N			
641	1	Admin.	N/A	N/A	Y	N	N			
642	1	Dining Facility	154	DHW	Y	N	Y			
643	1	Admin.	N/A	N/A	Y	Y	N	0.10		V
644	1	Admin.	N/A	N/A	Y	Y	N	0.33		V
645	1	Admin.	N/A	N/A	Y	N	N			
646	1	Admin.	N/A	N/A	Y	N	N			
647	1	Admin.	N/A	N/A	Y	Y	N	0.20		V
648	1	Admin.	N/A	N/A	Y	N	Y			
649	1	Admin.	N/A	N/A	Y	N	N			

3 Flanges
9 Valves

MECH. ROOM HTW LEAKS

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

Building No.	HTW Zone	Building Type	DHW Temp.	Water Sample	Mech Rm Survey	HTW Leaks	Other Leaks	HTW Drop/Sec	HTW Cup/Min
701	1	Health Clinic	152	DHW	Y	Y	N	1.00	✓
702	1	Ent. Center	143	DHW	Y	N	N		
703	1	Enl. Mens Club	N/A	N/A	LOCKED		Y		
704	1	Theater	N/A	N/A	Y	N	Y		
706	1	Branch Exchange	N/A	N/A	Y	N	Y		
708	1	Fitness Center	131	DHW	Y	N	Y		
710	1	Admin.	N/A	N/A	Y	N	Y		
712	1	Barracks	135	DHW	Y	N	Y		
713	1	Barracks	133	DHW	Y	N	Y		
714	1	Barracks	137	DHW	Y	N	Y		
715	1	Barracks	135	DHW	Y	Y	N	0.20	✓
717	1	Barracks	131	DHW	Y	N	N		
718	1	Barracks	124	DHW	Y	Y	Y	0.20	2 ✓
719	1	Barracks	112	DHW	Y	Y	N	1.00	✓
720	1	Barracks	130	DHW	Y	N	Y		
721	1	Admin.	N/A	N/A	Y	N	N		
722	1	Admin.	N/A	N/A	Y	Y	Y	5.00	✓
723	1	Admin.	N/A	N/A	Y	N	N		
724	1	Admin.	N/A	N/A	Y	N	N		
725	1	Admin.	N/A	N/A	Y	N	N		
726	1	Dining Facility	158	DHW	Y	N	Y		
727	N/A	Training Facility	N/A	N/A	Y	N/A	N		
728	1	Admin.	N/A	N/A	Y	Y	N	3.05	2 ✓
810	1	Barracks	131	DHW	Y	N	N		
811	1	Admin.	N/A	N/A	Y	N	N		
812	1	Admin.	N/A	N/A	Y	N	N		
813	1	Admin.	N/A	N/A	Y	N	N		
814	1	Admin.	N/A	N/A	Y	N	Y		
815	1	Admin.	N/A	N/A	Y	N	N		
816	1	Admin.	N/A	N/A	Y	N	Y		
818	1	Admin.	N/A	N/A	Y	N	N		
819	1	Admin.	N/A	N/A	Y	Y	N	0.13	3 ✓

Ø Flanges

11 Valves

MECH. ROOM HTW LEAKS

Fort Stewart - HTW Distribution System

Filename: FS-BLDGS.WB2

Building No.	HTW Zone	Building Type	DHW Temp.	Water Sample	Mech Rm Survey	HTW Leaks	Other Leaks	HTW Drop/Sec	HTW Cup/Min	
1160	3	D.S. Maint Fac	N/A	N/A	Y	Y	N	2.03		2V
1170	3	G.S. Maint Fac	N/A	N/A	Y	N	N			
1208	1	Tac Equip Shop	N/A	N/A	Y	N	Y			
1209	1	Tac Equip Shop	N/A	N/A	Y	N	N			
1211	1	Tac Equip Shop	N/A	N/A	Y	N	N			
1245	N/A	Tac Equip Shop	N/A	N/A	Y	N/A	Y			
1259	1	Tac Equip Shop	N/A	N/A	Y	Y	N		0.25	V
1261	2	Tac Equip Shop	N/A	N/A	N					
1265	2	Tac Equip Shop	N/A	N/A	Y	N	N			
1280	N/A	Tac Equip Shop	N/A	N/A	Y	N/A	Y			
1320	2	Tac Equip Shop	N/A	N/A	Y	N	N			
1330	2	Tac Equip Shop	N/A	N/A	Y	Y	N	0.13		V
1340	2	Tac Equip Shop	N/A	N/A	Y	N	N			
1412		C. Energy Plant	N/A	HTW	Y	Y				
1500	3	Div Logis Fac	N/A	N/A	w/ 1509?					
1503	3	Auto Hobby Shop	N/A	N/A	LOCKED					
1509	3	Div Logis Fac	N/A	N/A	Y	Y	Y	3.00		V
1510	3	Tac Equip Shop	N/A	N/A	N					
1540	3	Tac Equip Shop	95	PW	N					
1720	2	D.S. Maint Fac	148	DHW	Y	N-N/A	N			
1810	2	Tac Equip Shop	N/A	N/A	N					
1820	2	Tac Equip Shop	N/A	N/A	Y	N-N/A	N			
1840	2	Tac Equip Shop	N/A	N/A	Y	N	Y			
2115	1	Dental Clinic	N/A	N/A	Y	N	N			
2125	1	Chapel	120	DHW	Y	N	N			
3001	S	S. Energy Plant	N/A	N/A	Y	Y				
3002	S	Admin.	N/A	N/A	Y	Y	N	5.20		F+V
4502	S	Tac Equip Shop	N/A	N/A	N					
4528	S	Tac Equip Shop	N/A	N/A	N					
4577	S	Tac Equip Shop	N/A	N/A	N					
4578	S	Tac Equip Shop	N/A	N/A	N					
TOTALS		140			127	42	41	55.11 Drop/Sec	11.80 Cup/Min	
						Leaks (GPM) =		0.138	0.737	
						% of Total =		16%	84%	
						Total Leaks =		0.875 GPM		

1 Flange

6 Valves

RS&H

SUBJECT Fort Stewart HTW

DESIGNER W.T. TODD

CHECKER

AEP NO

SHEET OF

DATE

DATE

HTW losses during the heating season were substantially higher than the rest of 1995. These losses must be due to leaks in the SEP system and from building HVAC heating equipment.

Month/Yr.	Avg. HTW Losses	Annual Avg.	Difference
Jan/95	9.0 GPM	6.4 GPM	2.6 GPM
Feb/95	11.0 GPM	6.4 GPM	4.6 GPM
Mar/95	8.1 GPM	6.4 GPM	1.7 GPM

HEATING EQUIP. & SEP LOSSES:

$$2.6 \text{ GPM} \times 1440 \text{ min/day} \times 31 \text{ days} = 116{,}064 \text{ Gal}$$
$$4.6 \text{ GPM} \times 1440 \text{ min/day} \times 28 \text{ days} = 185472 \text{ Gal}$$
$$1.7 \text{ GPM} \times 1440 \text{ min/day} \times 31 \text{ days} = 75888 \text{ Gal}$$

TOTAL = 377,424 GAL

$$377424 \text{ GAL/YR} \div 365 \text{ days/YR} = \underline{1034 \text{ Gal/Day}}$$

$$1034 \text{ GAL/DAY} \div 1440 \text{ min/day} = \underline{0.718 \text{ Gal/min}}$$

SEP START-UP & HTW PIPING LEAKS

SUBJECT	FORT STEWART	AEP NO	
		SHEET	OF
DESIGNER	W. TODD	DATE	
CHECKER		DATE	

SEP START-UP LOSSES

See calculations for ECO-9.

HTW PIPING LEAKS - REPAIRED

Average loss during leak = 25000 Gal (see Figure 4.1-5)

Average loss w/o leak = 15000 Gal (see Figure 4.1-5)

Loss from leak = 10,000 Gal

Total losses = 10000 Gal/leak × 2 leaks = 20 000 GAL

$20\,000 \text{ GAL} \div 365 \text{ day/YR} = \underline{55 \text{ GAL/DAY}}$

$55 \text{ GAL/DAY} \div 1440 \text{ MIN/DAY} = \underline{0.038 \text{ GAL/MIN}}$

A.5 ENERGY DATA, BOILER LOGS AND MAKE-UP WATER DATA

Fort Stewart Central Energy Plant
Energy Consumption
Filename: FS-ENRGY.WQ1

Month	Yr	Wood Tons (1)	Wood MBtu (2)	Wood Cost (2)	#2 Oil Gals (1)	#2 Oil MBtu (3)	#2 Oil Cost (3)	Used Oil Gals (4)	Used Oil MBtu (5)	Used Oil Cost (5)	N.Gas CuFt (1)	N.Gas MBtu (6)	N.Gas Cost (6)	Total MBtu	Total Cost
7	94	6052	62941	65483	75497	10645	46808	0	0	0	5572730	5701	18563	79287	130854
8	94	8169	84958	88389	13822	1949	8570	12956	1749	0	874295	894	2878	89549	99836
9	94	4969	51678	53765	40667	5734	25214	17703	2390	0	352500	361	1056	60163	80034
10	94	3947	41049	42707	42608	6008	26417	18775	2535	0	598230	611	1790	50203	70913
11	94	5000	52000	54100	15884	2240	9848	24298	3280	0	1082030	1107	3488	58627	67436
12	94	6631	68964	71749	22257	3138	13799	9470	1278	0	1366090	1398	4363	74778	89912
1	95	6100	63441	66003	39741	5603	24639	8891	1200	0	1027820	1049	3199	71294	93841
2	95	5024	52250	54360	110411	15568	68455	13181	1779	0	1159730	1186	3368	70783	126182
3	95	5723	59519	61923	19404	2736	12030	11576	1563	0	518890	530	1463	64348	75417
4	95	1869	19438	20223	550	78	341	0	0	0	12995190	13268	37455	32783	58019
5	95	5322	55349	57584	6525	920	4046	11324	1529	0	550120	563	1724	58361	63354
6	95	4768	49587	51590	11466	1617	7109	5476	739	0	2081740	2128	6435	54071	65134
Averages		5298	55098	57323	33236	4686	20606	11138	1504	0	2348280	2400	7148	63687	85078
Totals		63574	661173	687874	398832	56235	247276	133650	18043	0	28179365	28796	85782	764246	1020931
% of Total			86.5%	67.4%		7.4%	24.2%		2.4%	0.0%		3.8%	8.4%		
Avg Cost			$1.04	/MBtu		$4.40	/MBtu		$0.00	/MBtu		$2.98	/MBtu	$1.34	/MBtu

(1) Source is Fort Stewart Operating Logs.
(2) Assumes 40% moisture and heating value of 5200 btu/lb; cost is $10.82/ton.
(3) Assumes heating value of 141000 btu/gal; cost is $0.62/gal.
(4) Source is monthly Oil Reports prepared at the CEP.
(5) Assumes heating value of 18000 btu/lb, 7.5 lb/gal; no cost.
(6) Uses heating value and cost from utility bills.

ELECTRIC BILLS

DPW, SERVICE BRANCH
FAX NO. 767-7570

TO: Bill Todd, RS:H, Jax, Fl.

FROM: Denise Kelley

DATE: 18 Aug 95

MESSAGE:

As Requested

$$\frac{\$3070487}{65{,}491{,}200 \text{ kwh}}$$

NO OF PAGES

Average elec. cost = $0.0469/kwh

A.5-4

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0475 B

83185300040200725084653008109500000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368
REMIT TO ↑

725084.65 SVC 520

8318530004020

725084.65 XXXXXXXXXX
Total Net Due

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

Account Number	Service Period From	To		
8318530004020	06-23	07-24-95	DSO DB 0.934350% FUEL CS $0.015097 ECON CR 0.009150%	Georgia Power Company HINESVILLE GA 31313 (912) 368-3376

RATE NAME	METER NO.	PRES READ	PREV READ	KWH CONST	KW HRS USED	BILL DEM	ACT DEM	ACT RKVA CD	Amount
520	E70396	4344	4110	19200	16608000	30701	30701	14632	725084.65
	EXCESS RKVA			4398					

CONSUMPTION FORWARDED METERS
E70398 0346 9715 19200

Sales Tax	Local Tax	Date of Bill	Service Name and Location	PLEASE PAY BY	Total Net Due
		0728	FORT STEWART DPW HERO RD FORT STEWART GA 31313	08-10-95	725084.65

*Current Bill Includes

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$725{,}085}{16{,}608{,}000 \text{ KWH}} = \$0.0437/\text{kwh}$$

A.5-5

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0480 B

83185300040200661320743007119500000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368

REMIT TO ↑

661320.74 SVC 520

8318530004020

661320.74 XXXXXXXXXX

Total Net Due

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

Account Number	Service Period From	To		
8318530004020	05-24	06-23-95	DSO DB 0.934350% FUEL CS $0.015097 ECON CR 0.009150%	Georgia Power Company HINESVILLE GA 31313 (912) 368-3376

RATE NAME	METER NO.	PRES READ	PREV READ	KWH CONST	KW HRS USED	BILL DEM	ACT DEM	ACT RKVA	CD	Amount
520	E70396	4110	3898	19200	14515200	29818	29818	14355		661320.74
	EXCESS RKVA			4416						

CONSUMPTION FORWARDED METERS
E70398 9715 9171 19200

Rec'd 6 Jul 95
Denise Nelling

Sales Tax	Local Tax	Date of Bill	Service Name and Location	PLEASE PAY BY	Total Net Due
		0629	FORT STEWART DPW HERO RD FORT STEWART GA 31313	07-11-95	661320.74

*Current Bill Includes

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$661{,}321}{14{,}515{,}200 \text{ kwh}} = \$0.0456/\text{kwh}$$

A.5-6

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0479 B

83185300040200604300088006129500000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368

REMIT TO ↑

604300.08	SVC 520
604300.08	XXXXXXXXXX
Total Net Due	

8318530004020

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

Account Number	Service Period From	To		
8318530004020	04-24	05-24-95	DSO DB 0.934350% FUEL CS $0.015097 ECON CR 0.009150%	Georgia Power Company HINESVILLE GA 31313 (912) 368-3376

RATE NAME	METER NO.	PRES READ	PREV READ	KWH CONST	KW HRS USED	BILL DEM	ACT DEM	ACT RKVA	CD	Amount
520	E70396	3898	3688	19200	13056000	27816	27725	13014		604300.08
	EXCESS RKVA			3772						

CONSUMPTION FORWARDED METERS
E70398 9171 8701 19200

Sales Tax	Local Tax	Date of Bill	Service Name and Location	PLEASE PAY BY	Total Net Due
		0531	FORT STEWART DPW HERO RD FORT STEWART GA 31313	06-12-95	604300.08

*Current Bill Includes

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$604,300}{13,056,000\ kwh} = \$0.0463/kwh$$

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0483 B

83185300040200524151140005109500000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368

REMIT TO ↑

524151.14	SVC 520
524151.14	XXXXXXXXXX

Total Net Due

8318530004020

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

Account Number	Service Period From	To	
8318530004020	03-27	04-24-95	DSO DB 0.934350% FUEL CS $0.015097 ECON CR 0.005660%

Georgia Power Company
HINESVILLE GA 31313
(912) 368-3376

RATE NAME	METER NO.	PRES READ	PREV READ	KWH CONST	KW HRS USED	BILL DEM	ACT DEM	ACT RKVA CD	Amount
520	E70396	3688	3506	19200	10060800	27816	24058	11096	524151.14
	EXCESS RKVA			3077					

CONSUMPTION FORWARDED METERS
E70398 8701 8359 19200

Sales Tax	Local Tax	Date of Bill	Service Name and Location	PLEASE PAY BY	Total Net Due
		0428	FORT STEWART DPW HERO RD FORT STEWART GA 31313	05-10-95	524151.14

*Current Bill Includes

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$524{,}151}{10{,}060{,}800\ \text{kwh}} = \$0.0521/\text{kwh}$$

A.5-8

PLEASE DO NOT STAPLE, FOLD OR PAPER CLIP

Georgia Power Company
96 Annex, Atlanta, Ga. 30396

1 0482 8

83185300040200555629843004119500000000

FORT STEWART
DPW
BLDG 1139
SERVICE BRANCH
FT STEWART GA 31314

Georgia Power Company
P. O. BOX 102473
68 ANNEX
ATLANTA GA 30368

REMIT TO ↑

555629.84 SVC 520

555629.84 XXXXXXXXXX

Total Net Due

8318530004020

PLEASE RETURN THIS PORTION WITH YOUR REMITTANCE.

Account Number	Service Period From	To		
8318530004020	02-22	03-27-95	DSO DB 0.934350% FUEL CS $0.015097 ECON CR 0.005660%	

Georgia Power Company
HINESVILLE GA 31313
(912) 368-3376

RATE NAME	METER NO.	PRES READ	PREV READ	KWH CONST	KW HRS USED	BILL DEM	ACT DEM	ACT RKVA	CD	Amount
520	E70396	3506	3307	19200	11251200	27816	19238	8358		555629.84
	EXCESS RKVA			1945						

CONSUMPTION FORWARDED METERS
E70398 8359 7972 19200

Sales Tax	Local Tax	Date of Bill	Service Name and Location	PLEASE PAY BY	Total Net Due
		0331	FORT STEWART DPW HERO RD FORT STEWART GA 31313	04-11-95	555629.84

*Current Bill Includes

PLEASE RETAIN THIS PORTION FOR YOUR RECORDS.
REFERENCE REVERSE SIDE FOR EXPLANATIONS AND DESCRIPTIONS OF RATE NAMES, ABBREVIATIONS AND BILLING CODES.

$$\frac{\$555{,}630}{11{,}251{,}200 \text{ kwh}} = \$0.0494/\text{kwh}$$

GEORGIA POWER COMPANY

Full Use Service to Governmental Institutions

SCHEDULE "G-10"

AVAILABILITY:

Throughout the Company's service area from existing lines of adequate capacity, except that service under this tariff is not available to a customer who is served from an underground network system or who applies for service after December 29, 1981 at a service level below 12 kV.

APPLICABILITY:

Full use service to large Federal, State, and Municipal agencies and institutions at a single delivery point through a single meter. This schedule is not applicable to Housing Projects or other Governmental agencies or institutions whose service requirements are predominantly residential, nor is it available to any customer who has more than one meter per structure.

TYPE OF SERVICE:

Single or three phase, 60 hertz, at a standard voltage.

MONTHLY RATE - Energy Charge Including Demand Charge:

Base Charge $55.00

All consumption (kWh) not greater than 300 hours times the billing demand:

First 50,000 kWh	@	**6.00¢ per kWh**
Next 150,000 kWh	@	**5.82¢ per kWh**
Next 800,000 kWh	@	**4.42¢ per kWh**
Over 1,000,000 kWh	@	**4.10¢ per kWh**

All consumption (kWh) in excess of 300 hours times the billing demand .... @ .... 1.15¢ per kWh

Minimum Monthly Bill:

$55.00 Base Charge plus $8.00 per kW of Billing Demand, but not less than $3,400.00 per month, plus excess kVAR charges and Fuel Cost Recovery as applied to the current month kWh.

FUEL COST RECOVERY:

The amount calculated at the above rate will be increased under the provisions of the Company's effective Fuel Cost Recovery Schedule, including any applicable adjustments.

DETERMINATION OF BILLING DEMAND:

The Billing Demand shall be based on the highest 30-minute kW measurement during the current month and the preceding eleven (11) months.

For the billing months of June through **September**, the Billing Demand shall be the greatest of:

(1) The current actual demand, or,
(2) Ninety-Five percent (95%) of the highest actual demand occurring in any previous applicable summer month (June through September), or,
(3) Sixty percent (60%) of the highest actual demand occurring in any previous applicable winter month (October through May).

For the billing months of **October** through **May**, the Billing Demand shall be the greater of:
(1) Ninety-Five percent (95%) of the highest summer month (June through September), or,
(2) Sixty percent (60%) of the highest winter month (October through May), including the current month.

In no case shall the Billing Demand be less than the greatest of:
(1) The contract minimum, or,
(2) Fifty percent (50%) of the total contract capacity, or,
(3) 3,000 kW for any customer applying for service under this rate subsequent to December 22, 1971, or,
(4) 6,000 kW for any customer applying for service under this rate subsequent to December 29, 1981.

Where there is an indiction of a power factor of less than 95% lagging, the Company may, at its option, install metering equipment to measure Reactive Demand. The Reactive Demand shall be the highest 30-minute kVAR measured during the month. The Excess Reactive Demand shall be kVAR which is in excess of one-third of the measured actual kW in the current month. The Company will bill excess kVAR at the rate of $0.27 per excess kVAR.

TERM OF CONTRACT:

Not less than one year.

REVENUE ADJUSTMENT:

The bill calculated at the above rate is subject to change in such an amount as may be determined under the provisions of the Company's Revenue Adjustment Rider, Schedule "RA-1", as approved by the Georgia Public Service Commission or as may be later amended.

Service hereunder subject to Rules and Regulations for Electric Service on file with the Georgia Public Service Commission.

Sub station capacity -
Evans -
Pembroke -

Effective with service rendered on and after December 4, 1991

FUEL OIL REPORTS

Denise Kelly
797-

Oil Report Jan 94 $0.59 Budget
$0.694 Actual 10/94

OH	174,119		CEP	125,813
Rec	41,987	From Hunter	Ldry	23,044
Total	216,106			
Used	66,349			
OH	149,757			

ON HAND

Natural Gas Used 31,190 Cu. Ft. $

Wood Fuel Tons

$10.82/Ton

OH	-0-		
Rec	7503.20	Tickets 19776-20036	- May 96
Total	7503.20		
Used	6627.00		
OH	875.20		

Oil Report Feb 94

OH	149,757	CEP	112,135
Rec	5,861 Used Oil	Ldry	23,944
Total	155,618		
Used	19,539 [(13,678 #2 Oil)(5861 Used Oil)]		
OH	136,079		

Natural Gas 2,548 Cu. Ft.

Wood Fuel Tons

OH	875.20
Rec	8470.69
Total	9345.89
Used	5845.89
OH	3500.00

Tickets 20037-20328

Oil Report Mar 94

OH 136,079
Rec -0-
Total 136,079
Used 5,736 #2 Oil (-0- Reclaimed Oil)
OH 130,343

CEP 106,399
Ldry 23,944

Natural Gas 6160 Cu. ft.

Wood Fuel Tons

OH 3500.00
Rec 6,608.03
Total 10,108.03
Used 5,884.00
OH 4,224.03

Tickets 20329-20554

Oil Report April 94

OH 130,343 CEP 101,987
Rec -0- Ldry 23,944
Total 130,343
Used 4,412 #2 (-0- Used Oil)
OH 125,931

Natural Gas 1,714,010 Cu. ft.

Wood Fuel Tons

OH 4,224.03
Rec 2996.84 Tickets 20555 - 20658
Total 7220.87 Ticket 20658 Void
Used 6870.87
OH 350.00

Oil Report May 94

OH 125,931
Rec -0-
Total 125,931
Used 4853 #2(-0-used oil)
OH 121,078

CEP 97,134
Ldry 23,944

Natural Gas 11,816,530 Cu. ft

Wood Fuel Tons

OH 350.00
Rec 6458.66
Total 6808.66
Used 5374.00
OH 1434.66

Tickets 20659 - 20885

Oil Report June 94

OH 121,078
Rec 181,200 From HAAF
Total 302,278
Used 184,388 #2 (-0- Used Oil)
O.H. 117,890

CEP 93,971
Ldry 23,919

Natural Gas 18,922,740 Cu.ft.

Wood Fuel Tons

OH 1434.66
Rec 1299.07
Total 2733.73
Used 613.00
OH 2120.73

Tickets 20886 – 20931

Oil Report July 94

OH 117,890
Rec 127,639 From HAAF
Total 245,529
Used 75,497 #2 Oil (-0- used oil)
OH 170,032

CEP 146,113
Ldry 23,919

Natural Gas 5570,730 Cu. ft.

Wood Fuel Tons

OH 2120.73
Rec 7,272.60
Total 9,393.33
Used 6,052.00
OH 3,341.33

Oil Report Aug 94

OH	170,032		CEP	147,437
Rec	15,146	#2 Heating Oil from FS	Ldry	23,919
Rec	12,956	Used Oil		
Total	198,134			
Used	26,778	(Used Oil 12,956✓)(13,822✓ #2 Oil)		
OH	171,356			

Natural Gas Used 874,295 Cu. ft. ✓

Wood Fuel Tons

OH	3,341.33	
Rec.	5321.54	Tickets 21193–21383
Total	8662.87	
Used	8169.00 ✓	
OH	493.87	

Oil Report Sept 94

OH	171,356	
Rec	3600	#2 Heating Oil from F.S.
Rec	17,703	Used Oil
Total	192,659	
Used	58,370	(17,703 Used Oil) (40,667 #2 Oil)
OH	134,289	

CEP 110,370
Ldry 23,919

Natural Gas Used 352,500 Cu. ft.

Wood Fuel Tons

OH	493.87
Rec	7,123.66
Total	7617.47
Used	4969.00
OH	2648.47

Tickets 21384-21644

OIL REPORT OCT 94

OH 134,289
REC 199,753 From Contractor
REC 18,775 Reclamed oil
TOTAL 352,817
USED 61,383 (18,775 Reclamed oil)(42,608 #2 Heating oil)
OH 291,434 ([illegible])

CEP 267,515
Ldry 23,919

NATUral Gas used 598,230

WOOD Fuel Tons

OH 2648.47
REC 6999.43
TOTAL 9647.90
USED 3947.00
OH 5700.90

Ticket 21645 Void
Tickets 21646 – 21877

OIL REPORT NOV 94

OH	291,434		CEP	237,717
REC	24,298	RECLAMED OIL	Ldry	23,919
TOTAL	315,732			
USED	54,096			
OH	261,636			

(24,298 Reclamed oil) (29,798 #2 Heating oil)

See next page

NATURAL GAS 1,082,030

WOOD FUEL TONS

OH	5700.90
REC	5465.80
TOTAL	11,166.70
USED	5,000
OH	6166.70

TICKETS 21889 - 22080

CORRECTED COPY of NOV 94 OIL REPORT

OH	291,434	CEP	251,631
~~REC~~	~~24,298 Used Oil~~	~~LPRY~~	23,919
TOTAL	315,732		
USED	40,182	(24,298 used Oil)(15,884 #2 Oil)	
OH	275,550		

Corrected copy necessary Due to a 13,914 Gallion EARROW in TANK Sounding

OIL REPORT DEC 94

OH 261,636 CEP 215,460

REC 9,470 RECLAMED OIL LDRY 23,919

TOTAL 271,106

USED 31,727 (9,470 Reclamed oil) (22,257 # 2 HEATING OIL)

OH 239,379

OIL ACTUALLY USED WAS 13,914 GALLIONS MORE THAN SHOWED IN USED COLUMN ABOVE, DUE TO ERROW IN NOV 94, REPORT.

NATURAL GAS 1,366,090 ✓

WOOD FUEL TONS TICKETS

OH 6166.70 22081 — 22231

REC 4264.48

TOTAL 10431.18

USED 6631.18 ✓

OH 3800.00

OIL REPORT JAN 95

OH 239,379
REC 8,891 Reclamed oil
TOTAL 248,270
USED $\boxed{48,632}$ (8891 Reclamed oil) (39,741 #2 Heating oil)
OH 199,638

CEP 175,759
LDRY 23,879

NATURAL GAS $\boxed{1,072,820}$ CF

WOOD FUEL TONS
OH 3800.00
REC 4996.10
TOTAL 8796.10
USED $\boxed{6100.10}$
OH 2696.00

TICKET 22232-22426
TICKET 22363 VOID

Janas

POL MONTHLY REPORT

Diane ~~Jay~~ 5440

FORT STEWART - FS#2

OPENING INVENTORY	239,379
RECEIPTS	31,291
BLDG 1412 8891	
POSTWIDE 22400	
ISSUES	$\boxed{71,032}$
BLDG 1412 $\boxed{48632}$	
POSTWIDE 22400	
BOOK BALANCE	199,638
DIFFERENCE (+ or -)	—
CLOSING INVENTORY	199,638

FORT STEWART - FUEL OIL RECOVERED

8891

REMARKS:

DATE 2 Feb 95 SIGNATURE Denise Kelley

OIL REPORT JAN 95

O.H	239,379		C.E.P	175,759
REC.	8,891	Reclamed oil	LDRY	23,579
TOTAL	248,270			
USED	$\boxed{48,632}$	(8891 Reclamed oil) (39,741 A.Z. Heating oil)		
OH	199,638			

NATURAL GAS $\boxed{1,072,820}$ C.F.

WOOD FUEL TONS

OH	3800.00	TICKET 22232–22426
REC	4996.10	TICKET 22363 VOID
TOTAL	8796.10	
USED	$\boxed{6100.10}$	
OH	2696.00	

A.5-28

OIL REPORT FEB 95

OH 199,638 — CEP 230,461
REC 13,181 (Reclamed oil) — L DRY 23,819
REC 165,053 (#2 HEATING oil From Contractor)
TOTAL 377,872
USED 123,592 (13,181 Reclamed oil)(110,411 #2 HEATING oil)
OH 254,280

NATURAL GAS 1,159,730 CF

WOOD FUEL TONS

OH 2696.00 — TICKET 22427 – 22696
REC 7116.96 — TICKET 22696 VOID
TOTAL 9812.96
USED 5024.00
OH 4788.96

OIL REPORT MARCH 95

OH 254,280 CEP 211057
REC 11,576 (RECLAMED OIL) LORY 23,819
TOTAL 265,856
USED 30,980 (11,576 RECLAMED OIL) (19,404 #2 HEATING OIL)
OH 234,876

NATURAL GAS 518,890 CF

WOOD FUEL TONS TICKET 22697-22852
OH 4788-96
REC 4076-56
TOTAL 8865-52
USED 5723-00
OH 3142-52

AUG-09-1995 08:32 P.04

OIL REPORT APRIL 95

OH 234,876
REC 638 (FROM UNITS)
TOTAL 235,514
USED 550 ✓ (#2 HEATING OIL)
OH 234,964

CEP 211,145
LORY 23,819

NATURAL GAS

12,995,190 CF

WOOD FUEL TONS

OH 3142.52
REC 897.77
TOTAL 4040.29
USED 1869.00
OH 2171.29

TICKET 22853 — 22888

AUG-09-1995 08:33 P.05

OIL REPORT MAY 95

OH 234,964 CEP 234,989
REC 30,369 FROM UNITS LDRY 23,819
REC 11,324 RECLAMED OIL
TOTAL 276,657
USED 17,849 (11,324 RECLAMED OIL)(6,525 #2 HEATING OIL)
OH 258,808

NATURAL GAS 550,120 CF

WOOD FUEL TONS

OH 2171.29
REC 4851.67 Tickets 22890-23069
TOTAL 7022.96 TICKET 22889 Void
USED 5322.00
OH 1700.96

OIL REPORT JUNE 95

OH 258,808 CEP 223,523
REC 5,476 (RECLAIMED OIL) LORY 23,819
TOTAL 264,284
USED 16,942 (5476 RECLAIMED OIL) (11,466 #2 HEATING OIL)
OH 247,342

NATURAL GAS 2,081,740 CF

WOOD FUEL TONS

OH 1700.96 TICKET 23070 - 23302
REC 6322.41 TICKET 23294 + 23295 VOID
TOTAL 8023.37
USED 4768.00
OH 3255.37

OIL REPORT JULY 95

OH	247,342	CEP 218,672
REC	10,615	LDRY 23,819
TOTAL	257,957	
USED	15,466	(10,615 RECLAMED OIL) (4,851 #2 HEATING OIL)
OH	242,491	

NATURAL GAS
3,381,820 CU. FT.

WOOD FUEL TONS

OH	3255.37	TICKET 23303 – 23524
REC	5805.28	
TOTAL	9060.65	
USED	5316.00	
OH	3744.65	

A.5-34

DPW, SERVICE BRANCH
FAX NO. 767-7570

TO: Bill Todd, RS:H, Jax, Fl.
FROM: Denise Kelley
DATE: 9 Aug 95
MESSAGE:
As Requested

NO OF PAGES

NATURAL GAS BILLS

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE JULY, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	5840	1.0000000
5141	6647	1.0000000

TOTAL MCF METERED 12487

CONVERT TO THERMS (10.23 /MCF X NET MCF = 127,738)

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	127,738	6.950	8,877.79
I-20 SEASONAL SUPPLY COST	127,738	24.750	31,615.16
BASE TAKE OR PAY COST	127,738	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	127,738	.000	0.00
SUB TOTAL			41,592.95
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$41,592.95
TOTAL CURRENT CHARGES			$41,592.95

Svcs Rec'd
15 Aug 94
Dennis Kelley

A.5-37

REPORT ID: [illegible]51 521 - JESUP-WAYCROSS
RUN DATE : 08/08/94

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

JULY

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.23	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	10,312	10,312	10,312
2	9,667	9,667	9,667
3	9,616	9,616	9,616
4	10,220	10,220	10,220
5	11,089	11,089	11,089
6	11,048	11,048	11,043
7	11,110	11,110	11,110
8	10,598	10,598	10,598
9	3,274	3,274	3,274
10	2,619	2,619	2,619
11	2,107	2,107	2,107
12	2,066	2,066	2,066
13	2,046	2,046	2,046
14	2,015	2,015	2,015
15	1,565	1,565	1,565
16	1,166	1,166	1,166
17	1,708	1,708	1,708
18	2,036	2,036	2,036
19	1,974	1,974	1,974
20	2,107	2,107	2,107
21	2,066	2,066	2,066
22	1,463	1,463	1,463
23	1,228	1,228	1,228
24	1,749	1,749	1,749
25	2,015	2,015	2,015
26	2,118	2,118	2,118
27	1,964	1,964	1,964
28	1,882	1,882	1,882
29	1,586	1,586	1,586
30	1,616	1,616	1,616
31	1,708	1,708	1,708
DAILY TOTAL	127,738	127,738	127,738
EXCESS REALLOC			
GRAND TOTAL	127,738	127,738	127,738

A.5-38

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE AUGUST, 1994

U S ARMY - FT. STEWART ACCOUNT 23558-0300-0-8 DISTRICT 4630267
ARTILLERY FIRING CTR I-20 COMMERCIAL RATE

METER NUMBER	USAGE	TEMPERATURE FACT.
686	2852	1.0000000
5141	3279	1.0000000
TOTAL MCF METERED	6131	

CONVERT TO THERMS (10.22 /MCF X NET MCF = 62,658)

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	62,658	6.950	4,354.73
I-20 SEASONAL SUPPLY COST	62,658	23.500	14,724.63
BASE TAKE OR PAY COST	62,658	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	62,658	.000	0.00
SUB TOTAL			20,179.36
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$20,179.36
TOTAL CURRENT CHARGES			$20,179.36

Svcs Rec'd
19 Sep 94
- Denise Kelley

A.5-39

EPORT ID: CMAM0051 521 - JESUP-WAYCROSS
UN DATE : 09/12/94

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

PAGE
RUN TIME
CMAB269-1

U S ARMY - FT. STEWART

AUGUST

A.5-40

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.22	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	2,238	2,238	2,238
2	2,259	2,259	2,259
3	2,167	2,167	2,167
4	2,320	2,320	2,320
5	2,259	2,259	2,259
6	1,635	1,635	1,635
7	2,003	2,003	2,003
8	2,075	2,075	2,075
9	2,575	2,575	2,575
10	2,678	2,678	2,678
11	1,870	1,870	1,870
12	1,421	1,421	1,421
13	1,216	1,216	1,216
14	2,064	2,064	2,064
15	2,494	2,494	2,494
16	2,259	2,259	2,259
17	2,197	2,197	2,197
18	2,095	2,095	2,095
19	1,921	1,921	1,921
20	1,870	1,870	1,870
21	1,942	1,942	1,942
22	2,064	2,064	2,064
23	2,146	2,146	2,146
24	2,054	2,054	2,054
25	2,146	2,146	2,146
26	1,533	1,533	1,533
27	1,267	1,267	1,267
28	1,758	1,758	1,758
29	2,085	2,085	2,085
30	2,075	2,075	2,075
31	1,972	1,972	1,972
AILY TOTAL	62,658	62,658	62,658
XCESS REALLOC			
RAND TOTAL	62,658	62,658	62,658

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE SEPTEMBER, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	2552	1.0000000
5141	3214	1.0000000
TOTAL MCF METERED	5766	

CONVERT TO THERMS (10.24 /MCF X NET MCF = 59,041)

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	59,041	6.950	4,103.35
I-20 SEASONAL SUPPLY COST	59,041	20.430	12,062.08
BASE TAKE OR PAY COST	59,041	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	59,041	.000	0.00
SUB TOTAL			17,265.43
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$17,265.43
TOTAL CURRENT CHARGES			$17,265.43

EPORT ID: CHAM0051 521 - JESUP-WAYCROSS
JN DATE : 10/07/94

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

RUN TIME: 11:52
CMAB269-1

U S ARMY - FT. STEWART

:PTEMBER

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.24	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	1,884	1,884	1,884
2	1,413	1,413	1,413
3	1,229	1,229	1,229
4	1,229	1,229	1,229
5	4,485	4,485	4,485
6	2,109	2,109	2,109
7	2,109	2,109	2,109
8	2,621	2,621	2,621
9	1,669	1,669	1,669
10	2,509	2,509	2,509
11	1,823	1,823	1,823
12	2,181	2,181	2,181
13	2,068	2,068	2,068
14	2,099	2,099	2,099
15	2,017	2,017	2,017
16	1,536	1,536	1,536
17	1,270	1,270	1,270
18	1,843	1,843	1,843
19	2,099	2,099	2,099
20	2,099	2,099	2,099
21	2,099	2,099	2,099
22	1,966	1,966	1,966
23	1,577	1,577	1,577
24	1,188	1,188	1,188
25	1,915	1,915	1,915
26	2,140	2,140	2,140
27	2,150	2,150	2,150
28	2,171	2,171	2,171
29	1,997	1,997	1,997
30	1,546	1,546	1,546
31	0	0	0
AILY TOTAL	59,041	59,041	59,041
XCESS REALLOC			
RAND TOTAL	59,041	59,041	59,041

A.5-42

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

CMAI

INTERRUPTIBLE MONTHLY BILLING INVOICE — OCTOBER, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	3251	1.0000000
5141	4191	1.0000000
TOTAL MCF METERED	7442	

CONVERT TO THERMS (10.22 /MCF X NET MCF = 76,056)

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	76,056	6.950	5,285.89
I-20 SEASONAL SUPPLY COST	76,056	20.880	15,880.49
BASE TAKE OR PAY COST	76,056	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	76,056	.000	0.00
SUB TOTAL			22,266.38
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$22,266.38
TOTAL CURRENT CHARGES			$22,266.38

Svc Rec'd
14 Nov 94
Dennis Wellery

A.5-43

REPORT ID: CMAM0051 521 - JESUP-WAYCROSS
RUN DATE : 11/10/94

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

OCTOBER

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.22	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	1,318	1,318	1,318
2	1,778	1,778	1,778
3	2,187	2,187	2,187
4	2,432	2,432	2,432
5	2,361	2,361	2,361
6	2,136	2,136	2,136
7	1,523	1,523	1,523
8	1,308	1,308	1,308
9	1,410	1,410	1,410
10	1,911	1,911	1,911
11	3,771	3,771	3,771
12	3,086	3,086	3,086
13	7,992	7,992	7,992
14	2,780	2,780	2,780
15	1,921	1,921	1,921
16	2,627	2,627	2,627
17	3,689	3,689	3,689
18	2,657	2,657	2,657
19	2,391	2,391	2,391
20	2,310	2,310	2,310
21	1,574	1,574	1,574
22	1,318	1,318	1,318
23	1,911	1,911	1,911
24	2,310	2,310	2,310
25	2,361	2,361	2,361
26	2,862	2,862	2,862
27	3,516	3,516	3,516
28	2,780	2,780	2,780
29	1,564	1,564	1,564
30	1,952	1,952	1,952
31	2,320	2,320	2,320
DAILY TOTAL	76,056	76,056	76,056
EXCESS REALLOC			
GRAND TOTAL	76,056	76,056	76,056

A.5-44

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE NOVEMBER, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	4710	1.0000000
5141	5805	1.0000000
TOTAL MCF METERED	10515	

CONVERT TO THERMS (10.23 /MCF X NET MCF = 107,571)

MONTHLY CUSTOMER CHARGE (BASED ON 93/12 USAGE OF 347,985 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	107,571	6.950	7,476.18
I-20 SEASONAL SUPPLY COST	107,571	23.540	25,322.21
BASE TAKE OR PAY COST	107,571	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	107,571	.000	0.00
SUB TOTAL			33,898.39
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$33,898.39
TOTAL CURRENT CHARGES			$33,898.39

Svcs Rec'd
19 Nov 94
Denise Kelly

A.5-45

REPORT ID: CM[illegible]051   521 - JESUP-WAYCROSS
RUN DATE : 12/09/94

U S ARMY - FT. STEWART

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

NOVEMBER

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.23	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	3,509	3,509	3,509
2	5,115	5,115	5,115
3	3,253	3,253	3,253
4	3,212	3,212	3,212
5	2,189	2,189	2,189
6	2,660	2,660	2,660
7	3,325	3,325	3,325
8	2,813	2,813	2,813
9	2,639	2,639	2,639
10	4,123	4,123	4,123
11	4,941	4,941	4,941
12	2,885	2,885	2,885
13	2,558	2,558	2,558
14	3,192	3,192	3,192
15	2,926	2,926	2,926
16	3,683	3,683	3,683
17	4,338	4,338	4,338
18	2,742	2,742	2,742
19	2,486	2,486	2,486
20	2,926	2,926	2,926
21	3,079	3,079	3,079
22	3,632	3,632	3,632
23	5,545	5,545	5,545
24	5,759	5,759	5,759
25	4,164	4,164	4,164
26	4,051	4,051	4,051
27	2,926	2,926	2,926
28	3,049	3,049	3,049
29	3,570	3,570	3,570
30	6,281	6,281	6,281
31	0	0	0
DAILY TOTAL	107,571	107,571	107,571
EXCESS REALLOC			
GRAND TOTAL	107,571	107,571	107,571

A.5-46

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE DECEMBER, 1994

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4630267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	8560	1.0000000
5141	10224	1.0000000

TOTAL MCF METERED 18784

CONVERT TO THERMS (10.23 /MCF X NET MCF = 192,157)

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	192,157	6.950	13,354.91
I-20 SEASONAL SUPPLY COST	192,157	23.700	45,541.21
BASE TAKE OR PAY COST	192,157	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	192,157	.000	0.00
SUB TOTAL			59,996.12
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$59,996.12
TOTAL CURRENT CHARGES			$59,996.12

REPORT ID: [illegible]051 521 - JESUP-WAYCROSS
RUN DATE : 01/12/95

ATLANTA [illegible] LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

DECEMBER

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.23	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	7,202	7,202	7,202
2	4,348	4,348	4,348
3	2,803	2,803	2,803
4	3,355	3,355	3,355
5	3,734	3,734	3,734
6	3,396	3,396	3,396
7	3,816	3,816	3,816
8	3,724	3,724	3,724
9	3,171	3,171	3,171
10	2,639	2,639	2,639
11	6,731	6,731	6,731
12	9,043	9,043	9,043
13	8,961	8,961	8,961
14	7,785	7,785	7,785
15	6,731	6,731	6,731
16	6,997	6,997	6,997
17	5,759	5,759	5,759
18	6,711	6,711	6,711
19	9,299	9,299	9,299
20	7,079	7,079	7,079
21	9,555	9,555	9,555
22	10,660	10,660	10,660
23	8,378	8,378	8,378
24	7,683	7,683	7,683
25	5,309	5,309	5,309
26	6,118	6,118	6,118
27	7,069	7,069	7,069
28	6,230	6,230	6,230
29	4,685	4,685	4,685
30	7,478	7,478	7,478
31	5,708	5,708	5,708
DAILY TOTAL	192,157	192,157	192,157
EXCESS REALLOC	-		
GRAND TOTAL	192,157	192,157	192,157

A.5-48

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY CMAN
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE JANUARY, 1995

U S ARMY - FT. STEWART ACCOUNT 23558-0300-0-8 DISTRICT 4630267
ARTILLERY FIRING CTR I-20 COMMERCIAL RATE

METER NUMBER	USAGE	TEMPERATURE FACT.
686	10681	1.0000000
5141	12680	1.0000000
TOTAL MCF METERED	23361	

CONVERT TO THERMS (10.21 /MCF X NET MCF = 238,514)

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	238,514	6.950	16,576.72
I-20 SEASONAL SUPPLY COST	238,514	23.070	55,025.18
BASE TAKE OR PAY COST	238,514	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	238,514	.000	0.00
SUB TOTAL			72,701.90
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$72,701.90
TOTAL CURRENT CHARGES			$72,701.90

Svcs Rec'd
17 Feb 95
Denise Kelley

A.5-49

EPORT ID: CHAM0051 521 - JESUP-WAYCROSS
JN DATE : 02/13/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

JANUARY

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.21	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	4,411	4,411	4,411
2	6,953	6,953	6,953
3	8,964	8,964	8,964
4	11,221	11,221	11,221
5	11,313	11,313	11,313
6	4,390	4,390	4,390
7	5,095	5,095	5,095
8	8,648	8,648	8,648
9	8,239	8,239	8,239
10	7,024	7,024	7,024
11	6,238	6,238	6,238
12	4,748	4,748	4,748
13	2,930	2,930	2,930
14	5,166	5,166	5,166
15	7,147	7,147	7,147
16	7,392	7,392	7,392
17	6,749	6,749	6,749
18	6,443	6,443	6,443
19	7,821	7,821	7,821
20	8,352	8,352	8,352
21	7,831	7,831	7,831
22	8,025	8,025	8,025
23	11,333	11,333	11,333
24	11,915	11,915	11,915
25	9,904	9,904	9,904
26	9,495	9,495	9,495
27	7,167	7,167	7,167
28	5,728	5,728	5,728
29	5,809	5,809	5,809
30	10,812	10,812	10,812
31	11,251	11,251	11,251
AILY TOTAL	238,514	238,514	238,514
XCESS REALLOC			
RAND TOTAL	238,514	238,514	238,514

A.5-50

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

CMA

INTERRUPTIBLE MONTHLY BILLING INVOICE FEBRUARY, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	9591	1.0000000
5141	11318	1.0000000

TOTAL MCF METERED 20909

CONVERT TO THERMS (10.23 /MCF X NET MCF = 213,897)

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	213,897	6.950	14,865.84
I-20 SEASONAL SUPPLY COST	213,897	20.920	44,747.25
BASE TAKE OR PAY COST	213,897	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	213,897	.000	0.00
SUB TOTAL			60,713.09
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$60,713.09
TOTAL CURRENT CHARGES			$60,713.09

Serv Rec'd
21 Mar 95
Denise Kelley

EPORT ID: CMAM0051 521 - JESUP-WAYCROSS
UN DATE : 03/14/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

FEBRUARY

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.23	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	8,685	8,685	8,685
2	5,964	5,964	5,964
3	4,655	4,655	4,655
4	9,094	9,094	9,094
5	9,483	9,483	9,483
6	12,818	12,818	12,818
7	15,232	15,232	15,232
8	15,181	15,181	15,181
9	11,447	11,447	11,447
10	6,956	6,956	6,956
11	6,690	6,690	6,690
12	6,977	6,977	6,977
13	8,614	8,614	8,614
14	7,304	7,304	7,304
15	5,023	5,023	5,023
16	3,570	3,570	3,570
17	3,703	3,703	3,703
18	6,097	6,097	6,097
19	5,862	5,862	5,862
20	6,251	6,251	6,251
21	9,105	9,105	9,105
22	8,399	8,399	8,399
23	6,588	6,588	6,588
24	5,667	5,667	5,667
25	6,128	6,128	6,128
26	5,463	5,463	5,463
27	9,289	9,289	9,289
28	3,652	3,652	3,652
29	0	0	0
30	0	0	0
31	0	0	0
AILY TOTAL	213,897	213,897	213,897
XCESS REALLOC			
RAND TOTAL	213,897	213,897	213,897

A.5-52

CMA

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE MARCH, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	7176	1.0000000
5141	8484	1.0000000

TOTAL MCF METERED 15660

CONVERT TO THERMS (10.21 /MCF X NET MCF = 159,888)

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	159,888	6.950	11,112.22
I-20 SEASONAL SUPPLY COST	159,888	19.980	31,945.62
BASE TAKE OR PAY COST	159,888	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	159,888	.000	0.00
SUB TOTAL			44,157.84
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$44,157.84
TOTAL CURRENT CHARGES			$44,157.84

Svc Rec'd
18 Apr 95
Dennis Kelley

A.5-53

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

MARCH

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.21	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	4,421	4,421	4,421
2	5,901	5,901	5,901
3	4,993	4,993	4,993
4	4,717	4,717	4,717
5	5,922	5,922	5,922
6	4,482	4,482	4,482
7	4,115	4,115	4,115
8	6,003	6,003	6,003
9	10,169	10,169	10,169
10	11,313	11,313	11,313
11	5,758	5,758	5,758
12	4,809	4,809	4,809
13	4,727	4,727	4,727
14	4,799	4,799	4,799
15	4,104	4,104	4,104
16	4,574	4,574	4,574
17	3,655	3,655	3,655
18	4,390	4,390	4,390
19	5,381	5,381	5,381
20	4,625	4,625	4,625
21	4,462	4,462	4,462
22	4,809	4,809	4,809
23	4,809	4,809	4,809
24	4,492	4,492	4,492
25	4,390	4,390	4,390
26	5,381	5,381	5,381
27	4,625	4,625	4,625
28	4,462	4,462	4,462
29	4,809	4,809	4,809
30	4,809	4,809	4,809
31	3,982	3,982	3,982
AILY TOTAL	159,888	159,888	159,888
XCESS REALLOC			
RAND TOTAL	159,888	159,888	159,888

.ıLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

CMA

INTERRUPTIBLE MONTHLY BILLING INVOICE   APRIL, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	10595	1.0000000
5141	13917	1.0000000
TOTAL MCF METERED	24512	

CONVERT TO THERMS (10.21 /MCF X NET MCF = 250,269)

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	250,269	6.950	17,393.70
I-20 SEASONAL SUPPLY COST	250,269	20.840	52,156.06
BASE TAKE OR PAY COST	250,000	.000	0.00
EXCESS TAKE OR PAY COST	269	.000	0.00
BASE ENVIRONMENTAL RESPONSE COST	250,000	.000	0.00
EXCESS ENVIRONMENTAL RESPONSE COST	269	.000	0.00
SUB TOTAL			70,649.76
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$70,649.76
TOTAL CURRENT CHARGES			$70,649.76

Sirsheld
18 May 95
Denise Kelley

A.5-55

REPORT ID: CMAM0051 521 - JESUP-WAYCROSS
RUN DATE : 05/09/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

APRIL

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.21	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	13,610	13,610	13,610
2	13,610	13,610	13,610
3	13,610	13,610	13,610
4	13,610	13,610	13,610
5	13,610	13,610	13,610
6	14,008	14,008	14,008
7	14,223	14,223	14,223
8	14,365	14,365	14,365
9	16,407	16,407	16,407
10	14,468	14,468	14,468
11	12,763	12,763	12,763
12	12,783	12,783	12,783
13	13,018	13,018	13,018
14	12,375	12,375	12,375
15	11,731	11,731	11,731
16	12,038	12,038	12,038
17	4,880	4,880	4,880
18	2,553	2,553	2,553
19	2,461	2,461	2,461
20	2,226	2,226	2,226
21	1,725	1,725	1,725
22	1,358	1,358	1,358
23	2,011	2,011	2,011
24	3,043	3,043	3,043
25	3,339	3,339	3,339
26	2,746	2,746	2,746
27	2,491	2,491	2,491
28	1,899	1,899	1,899
29	1,399	1,399	1,399
30	1,909	1,909	1,909
31	0	0	0
DAILY TOTAL	250,269	250,269	250,269
EXCESS REALLOC			
GRAND TOTAL	250,269	250,269	250,269

A.5-56

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE MAY, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	3038	1.0000000
5141	3586	1.0000000
TOTAL MCF METERED	6624	

CONVERT TO THERMS (10.24 /MCF X NET MCF = 67,830)

MONTHLY CUSTOMER CHARGE (BASED ON 94/06 USAGE OF 310,484 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	67,830	6.950	4,714.19
I-20 SEASONAL SUPPLY COST	67,830	21.990	14,915.82
BYPASS RECOVERY FACTOR	67,830	.050	33.92
SUB TOTAL			20,763.93
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$20,763.93
TOTAL CURRENT CHARGES			$20,763.93

Svcs Rec'd
19 Jun 95

A.5-57

REPORT ID: CMAM0051 521 - JESUP-WAYCROSS
RUN DATE : 06/09/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

MAY

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.24	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	2,314	2,314	2,314
2	2,509	2,509	2,509
3	2,509	2,509	2,509
4	2,284	2,284	2,284
5	1,669	1,669	1,669
6	1,413	1,413	1,413
7	2,314	2,314	2,314
8	3,205	3,205	3,205
9	2,109	2,109	2,109
10	2,109	2,109	2,109
11	2,386	2,386	2,386
12	1,792	1,792	1,792
13	1,280	1,280	1,280
14	2,028	2,028	2,028
15	2,468	2,468	2,468
16	2,294	2,294	2,294
17	2,273	2,273	2,273
18	2,314	2,314	2,314
19	1,853	1,853	1,853
20	1,710	1,710	1,710
21	2,099	2,099	2,099
22	2,468	2,468	2,468
23	2,601	2,601	2,601
24	2,376	2,376	2,376
25	2,376	2,376	2,376
26	1,987	1,987	1,987
27	1,751	1,751	1,751
28	1,731	1,731	1,731
29	2,365	2,365	2,365
30	2,601	2,601	2,601
31	2,642	2,642	2,642
DAILY TOTAL	67,830	67,830	67,830
EXCESS REALLOC			
GRAND TOTAL	67,830	67,830	67,830

A.5-58

ATLANTA GAS LIGHT COMPANY - GEORGIA NATURAL GAS - SAVANNAH NATURAL GAS COMPANY
P.O.BOX 105256 ATLANTA, GA 30348-5256

INTERRUPTIBLE MONTHLY BILLING INVOICE — JUNE, 1995

U S ARMY - FT. STEWART
ARTILLERY FIRING CTR

ACCOUNT 23558-0300-0-8
I-20 COMMERCIAL RATE

DISTRICT 4530267

METER NUMBER	USAGE	TEMPERATURE FACT.
686	4548	1.0000000
5141	5173	1.0000000
TOTAL MCF METERED	9721	

CONVERT TO THERMS (10.22 /MCF X NET MCF = 99,348)

MONTHLY CUSTOMER CHARGE (BASED ON 95/04 USAGE OF 250,269 THERMS) $1,100.00

	THERMS	CENTS/THM	AMOUNT
I-20 COMMODITY CHARGE	99,348	6.950	6,904.69
I-20 SEASONAL SUPPLY COST	99,348	22.140	21,995.65
BYPASS RECOVERY FACTOR	99,348	.050	49.67
SUB TOTAL			30,050.01
.00 % SALES TAX			0.00
TOTAL CURRENT AMOUNT			$30,050.01
TOTAL CURRENT CHARGES			$30,050.01

A.5-59

REPORT ID: CMAM0051 521 - JESUP-WAYCROSS
RUN DATE : 07/10/95

ATLANTA GAS LIGHT COMPANY
INTERRUPTIBLE CUSTOMER WORKSHEET (THERMS)
ACCOUNT # 23558 0300 0 8

U S ARMY - FT. STEWART

JUNE

	TOTAL VOLUMES METERED WITH BTU FACTOR OF 10.22	I-20 INTERRUPTIBLE TOTAL USED	I-20 SEASONAL SUPPLY USED
1	2,473	2,473	2,473
2	2,085	2,085	2,085
3	1,758	1,758	1,758
4	3,178	3,178	3,178
5	8,953	8,953	8,953
6	3,260	3,260	3,260
7	2,494	2,494	2,494
8	2,269	2,269	2,269
9	1,983	1,983	1,983
10	1,543	1,543	1,543
11	2,667	2,667	2,667
12	12,826	12,826	12,826
13	4,527	4,527	4,527
14	2,167	2,167	2,167
15	2,279	2,279	2,279
16	1,983	1,983	1,983
17	1,533	1,533	1,533
18	2,156	2,156	2,156
19	2,514	2,514	2,514
20	2,340	2,340	2,340
21	2,126	2,126	2,126
22	2,310	2,310	2,310
23	1,574	1,574	1,574
24	1,502	1,502	1,502
25	1,789	1,789	1,789
26	2,300	2,300	2,300
27	2,289	2,289	2,289
28	2,064	2,064	2,064
29	4,946	4,946	4,946
30	13,460	13,460	13,460
31	0	0	0
DAILY TOTAL	99,348	99,348	99,348
EXCESS REALLOC			
GRAND TOTAL	99,348	99,348	99,348

A.5-60

BOILER LOGS

A.5-62

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO: 1412 | MONTH: DECEMBER 1996

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER #4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS (6)	#2 FUEL USED GAL. * (7)	NAT GAS CU. FT. (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	BOILER 2 (14)	BOILER #4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER #4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	CHILL WATER m/u (23)
1	200			1532	1532	202	505	23470	49			7430			7.2			420	380	6	EF		5600
2	200			1506	1506	207	326	13060	53			9300			7.2			420	380	6	CP		4100
3	200			1491	1491	197	477	5420	54			10090			7.2			420	380	6	EF		5100
4	200			1427	1427	196	313	37120	58			8930			7.2			420	380	6	CP		5700
5	200			1393	1393	189	570	14370	66			9170			7.2			420	380	6	RP		6100
6	200			1341	1341	100	581	15700	60			6600			7.6			450	378	6	UB		6500
7	200			1419	1419	195	255	9910	53			9930			7.6			450	378	6	DR		6000
8	200			1673	1673	217	320	15920	42			7770			7.5			450	378	6	CP		2800
9	200			1717	1717	233	596	6820	44			7430			7.4			450	380	6	EF		3200
10	200			1830	1830	249	560	12910	32			9410			7.5			450	380	6	CP		2600
11	200			1890	1890	254	388	37390	33			9100			7.0			450	380	6	EF		3000
12	200		62	1876	1938	252	360	9430	39			8010		7.2	7.0			450	380	6	CP		1950
13	200			1705	1705	228	393	110	46			9780			6.0			450	380	6	RP		2950
14	200			1497	1497	206	288	2130	57			9470			6.0			450	380	6	DR		4300
15	200			1312	1312	176	290	260	63			10930			6.0			450	380	6	EF		4300
16	200			1340	1340	183	332	3350	66			8650			6.0			450	380	6	CP		2100
17	200			1390	1390	190	315	70	56			9770			6.0			450	380	6	EF		2700
18	200			1459	1459	201	555	50	55			8500			6.5			450	380	6	CP		2100
19	200			1406	1406	187	346	50	63			6790			6.5			450	380	6	EF		1800
20	200			1565	1565	210	303	2760	46			7300			6.5			450	380	6	RP		1300
21	200			1872	1872	254	306	30	37			7620			6.5			450	380	6	DR		2200
22	200			1894	1894	261	315	100	36			4410			6.6			450	380	6	CP		800
23	200			1846	1846	249	181	4760	37			6220			6.5			450	380	6	EF		1700
24	200			1935	1935	254	674	70	31			7180			6.5			450	380	6	CP		1900
25	200			1929	1929	264	180	30	33			4420			6.5			450	380	6	EF		1300
26	200			1963	1963	251	1074	30	33			5050			6.5			450	380	6	DR		1600
27	200			1802	1802	205	2504	1560	37			7010			6.4			450	376	6	WB		1600
28	200			1808	1808	200	2918	110	34			9310			6.4			450	375	6	PR		1800
29	200			1850	1850	206	2846	50	36			10690			6.5			450	375	6	EF		2800
30	200			1703	1703	216	1102	-0-	49			11030			7.0			450	375	6	CP		2300
31	200			1528	1528	193	1030	90	55			12610			6.5			440	375	6	EF		4800
TOTAL	6200		62	50899	50961	6625	21203	216880	1453			259510		7.2	209			13800	11740	186			97,000
MAXIMUM	200		62	1963	1963	264	2918	37390	66			12610		7.2	7.6			450	380	6			6500
MINIMUM	200		62	1312	1312	100	180	30	31			4410		7.2	6.0			420	375	6			800
AVERAGE	200		62	1642	1644	214	683	6996	47			8371		7.2	6.7			445	378	6			3129
EVAPORATION LB. STEAM PER LB. STD. FUEL																							

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2395; OIL: 118; NAT GAS: 8944

REMARKS: *N° 2 OIL: 9709; RECLAIMED OIL F.S.: 11,494

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Rodney A. Phillips | DATE: 14 Jan 96 | APPROVED BY: | DATE: | POST ENGINEER: | DATE:

DA FORM 3967, 1 NOV 72 REPLACES DA FORM 560, 1 JUN 58, WHICH WILL BE USED.

A.5-63

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP | BLDG. NO: 1412 | MONTH: NOV 95

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 2 1,000 LB. (2)	STEAM PRODUCED BOILER 3 1,000 LB. (3)	STEAM PRODUCED BOILER 3/4 1,000 LB. (4)	STEAM PRODUCED TOTAL 1,000 LB. (5)	WARD WATER TONS ~~FEED~~ ~~BOILER~~ 1,000 LB. (6)	#2 FUEL USED ~~LB. M.C.F.~~ GAL. (7)	N.G. ~~EVAP. LB. PER UNIT~~ (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. W.O. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3/4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS TEMPERATURE BOILER 2 °F. (17)	FLUE GAS TEMPERATURE BOILER 3/4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 O/S (22)	CWMU (23)
1	200	(616	616		1232	—	—	763,201	67	—		4020		7.1			450	450	377	0	D.T	0	1100
2	200	200	647		847			555800	74			5090		7.1	7.1		450	450	378	0	[illegible]		500
3	200		864		864	—	—	638190	71	—		3730			7.1			450	379	0	KS	0	200
4	200		880		880			614510	55	—		7330							380	0	W	—	200
5	200		846		846			608980	45	—		2280							380	0	Dn		100
6	200	54	877		931			697630	52			7650							380	0	Dn		100
7	200	96	912		1007			679460	66	-		2440			7.1			450	380	0	DT		1200
8	200	212	800		1012			806800	54	—		3700		7.1	7.1		450	450	380	0	[illegible]		800
9	200	120	869		989	—	—	502700	45	—		9110		7.1	7.1		450	450	380	0	[illegible]	0	1500
10	200	340	803		1143		#452	872100	52	-		10140		7.1	7.1		450	450	380	0	[illegible]	0	2500
11	200	135	456	602	1193	52	1690	439980	64	-		5410		—	—		—	—	378	[illegible]	W	223	1800
12	200			1348	1348	186	8	7630	42	-		1,830							380	[illegible]	W	1	1900
13	200			1361	1361	187	0	13,820	47	—		10,000			7.0			420	380	6	[illegible]	0	3300
14	200			1377	1377	188	66	13490	49			9320			—			—	377	6	W	9	1800
15	200			1619	1619	214	0	7800	44	516		12200	Warming up-3001					430	378	6	[illegible]	63	2400
16	200			1661	1661	211	—	5416	42	1050		12,450	"	"	"				377	6	DT	129	4000
17	200			1647	1647	209	—	20080	45	1067		16,220	"	"	"				377	6	[illegible]	131	5500
18	200			1579	1579	190	—	8730	49	1614		14560	OFF	"	"				378	6	W	198	3200
19	200			1410	1410	170	—	13480	55	1430		10130	off	"	"				377	6	[illegible]	176	4500
20	200			1415	1415	165	—	15080	55	1755		13380		"	"				377	6	[illegible]	215	7100
21	200			1418	1418	185	—	15030	57	172		14530							378	6	[illegible]	21	9300
22	200			1586	1586	192	—	3066	44	1510		14460							378	6	RS	185	6,200
23	200			1642	1642	179		16,200	46	2748		10020							378	6	M.	337	4,400
24	200			1593	1593	190		10820	51°	1765		7950							378	6	Dn	217	4600
25	200			1626	1626	203	1140	9910	43	—		11720							[illegible]	6	R.T	166	4,100
26	200			1666	1666	207	1264	15,030	47	—		4,100							[illegible]	6	R.T	166	[illegible]
27	200			1602	1602	215	285	15,810	52°	—		9450							378	6	Dn	38	3500
28	200			1453	1453	192	430	15,230	65	—		10070							378	6	E.T.	56	8100
29	200			1310	1310	177	208	24,910	60	—		9450							378	6	Dn	27	9800
30	200			1581	1581	217	44	11,390	47	—		7410							377	6	DT	6	5700
31																							
TOTAL												261230											
MAXIMUM																							
MINIMUM																							
AVERAGE																							

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM [illegible]

A.5-64

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO: 1412 | MONTH: OCTOBER 1995

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3/4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD ~~FEED WATER~~ TONS ~~BOILER~~ ~~1,000 LB.~~ (6)	Nº2 OIL FUEL USED ~~LB. M.C.F.~~ GAL. * (7)	NAT GAS EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3/4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS BOILER 2 °F. (17)	FLUE GAS BOILER 3/4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	CHILL WATER M/U (23)
1	200			1544	1544	203	370	12860	71			4280			6.0			465	375	6	EF		2740
2	200			1513	1513	209	354	12050	72			4230			6.0			466	376	6	EB		3460
3	200			1647	1647	207	212	11160	74			6570			6.0			465	377	6	EB		2900
4	200			1838	1838	208	867	15380	81			6580			6.0			465	376	6	DR		2600
5	200			1886	1886	200	915	10430	78			6180			6.0			465	376	6	DR		2000
6	200			1773	1773	204	507	25400	83			5740			6.0			465	376	6	EF		1800
7	200			1823	1823	201	775	19430	77			7050			6.0			465	371	6	EF		2300
8	200			1830	1830	202	285	14200	70			6500			6.0			465	376	6	EF		1700
9	200			1787	1787	207	390	14570	70			14570			6.0			465	377	6	DT		1700
10	200			1983	1983	200	559	10130	69			10080			6.0			465	376	6	EG		2800
11	200			1813	1813	200	918	10860	70			12230			6.0			465	375	6	EB		3400
12	200			1760	1760	202	321	29590	68			6710			6.0			465	375	6	DR		2300
13	200			1861	1861	207	270	20570	75			7390			6.0			465	375	6	EF		2900
14	200	120/128	60	1419	1719	100	319	170730	75			1110	7.0	7.0	6.0	465	465	465	377	6	WB		2900
15	200		708	3) 739	1447			276300	62			7610		7.0	6.0		465	465	376		RP		2400
16	200		700	3) 709	1409			751090	58			8260		7.0	6.0		450	450	378		WB		3100
17	200	739	739		1478			770410	61			5620	7.2	7.2	6.0	465	450	450	378		RP		2900
18	200		723	3) 723	1446			991800	64			6820	7.2	7.2		465	460		378		FU		2400
19	200	720	720		1440			932930	67			7070	7.2	7.2		465	460		378		DR		2300
20	200	720	720		1440			857570	70			7160	7.2	7.2		450	450		378		RP		2400
21	200	720	720		1440			875040	59			7740	7.1	7.1		450	450		377		WB		3300
22	200	720	720		1440			765643	59			7410	7.1	7.1		450	450		377		RP		3000
23	200	720	720		1440			895771	65			6120	7.1	7.1		450	450		377		RP		3000
24	200	720	720		1440			936356	72			4970	7.1	7.1		450	450		375		RP		2900
25	200	720	720		1440			1231820	75			5040	7.1	7.1		450	450		371		DT		2300
26	200	720	720		1440			926200	72			5710	7.1	7.1		450	450		376		FU		2900
27	200	720	720		1440			913450	78			6750	7.1	7.1		450	450		376		RP		2200
28	200	720	720		1440			915350	64			4370	7.1	7.1		450	450		376		RP		2200
29	200	750	750		1500			993420	55			3980	7.1	7.1		450	450		377		RP		2100
30	200	720	720		1440			876880	56			6330	7.1	7.1		450	450		376		RP		2900
31	200	240	720	3) 480	1440			900010	62			5110	7.1	7.1	7.1	450	450	450	377		RP		1500
TOTAL	6200	9769	12320	277 / 2447	49337	2750	7062	15593280	2162			205290	113.9	127.9	109.1	7260	8130	8325	11671	84			81500
MAXIMUM	200	750	750	739 / 1983	1983	209	918	1031880	83			14570	7.2	7.2	7.1	465	465	465	378	6			3500
MINIMUM	200	120	60	120 / 1419	1409	100	212	10130	58			3980	7.0	7.0	6.0	450	450	450	375	6			1500
AVERAGE	200	651	684	692 / 1748	1592	196	504	503009	69			6622	7.1	7.1	6.1	453	451	462	376	6			2629
EVAPORATION LB. STEAM PER LB. STD. FUEL																							

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 990; OIL: 39; NAT GAS: 643

REMARKS: * Nº2 OIL 7062; RECLAIMED OIL F.S.: 0

PREPARED BY: Rodney G. Phillips | DATE: 12 NOV 95

APPROVED BY: | DATE: | POST ENGINEER: | DATE:

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

SEPT

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

A.5-65

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO. 1412

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2/3 1,000 LB. (3)	BOILER 4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD FEED TONS (6)	NO 2 OIL FUEL USED GAL. (7)	NAT GAS (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	% CO_2 BOILER 1 (13)	% CO_2 BOILER 2/3 (14)	% CO_2 BOILER 4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS BOILER 2/3 °F. (17)	FLUE GAS BOILER 4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)
1	200		385	1626	2011	204	1100	24070	78			6230		7.2	6.0		420	465	375
2	200		360	1838	2198	250	145	265400	78			7940		7.2	6.0		420	465	375
3	200		60	2010	2070	271	320	65130	74			8070		7.2	6.0		420	465	375
4	200		264	1889	2153	245	590	181000	76			7700		7.2	6.0		420	465	375
5	200			2060	2060	279	250	44180	68			7500			6.0			465	375
6	200			1802	1802	202	1818	25200	70			8860			6.0			465	375
7	200			1716	1716	236	871	22740	71			5560			6.0			465	375
8	200			1666	1666	223	350	40270	75			10300			6.0			465	375
9	200			1718	1718	235	120	29640	77			7020			6.0			465	375
10	200			1694	1694	230	160	24600	78			8560			6.0			465	375
11	200			1702	1702	230	190	28060	76			6130			6.0			466	376
12	200			1677	1677	226	265	26100	74			6120			6.0			466	376
13	200			1689	1689	229	201	24940	76			6990			6.0			466	376
14	200			1717	1717	236	443	101820	77			11980			6.0			466	376
15	200			1667	1667	225	269	29100	78			6280			6.0			466	376
16	200			1666	1666	225	200	20508	80			6570			6.0			466	376
17	200		73	1495	1568	200	345	24200	80			7990		7.2	6.0		420	465	375
18	200			1642	1642	222	253	46700	77			8650			6.0			465	375
19	200			1601	1601	207	97	14400	75			8510			6.0			465	375
20	200			1585	1585	215	142	19340	73			9720			6.0			465	375
21	200			1578	1578	218	289	109180	75			7250			6.0			465	375
22	200			1538	1538	205	360	106570	81			6760			6.0			466	376
23	200			1574	1574	210	350	23530	71			4550			6.0			466	376
24	200			1524	1524	206	212	24100	55			6280			6.0			466	376
25	200		1080	404	1484	44	215	767800	68			6330		7.2	6.0		420	466	376
26	200		100	1499	1599	160	169	58530	70			3780		7.2	6.0		420	466	376
27	200			1507	1507	148	2562	11920	70			4080			6.0			466	376
28	200			1502	1502	206	3544	10802	70			7400			6.0			466	376
29	200			1529	1529	174	3397	15090	67			5020			6.0			466	376
30	200			1475	1475	202	2503	16620	68			6320			6.0			466	376
31																			
TOTAL	6,000		2322	48590	50912	6363	21730	[illegible]	2276			216450		50.4	180.0		2940	13966	11265
MAXIMUM	200		1080	2060	2198	279	3544	767800	81			11980		7.2	6.0		420	466	376
MINIMUM	200		60	404	1475	44	97	10802	55			3780		7.2	6.0		420	465	375
AVERAGE	200		332	1620	1697	213	725	73343	76			7215		7.2	6.0		420	466	376

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2291 ; OIL: 121 ; NAT GAS: 91

REMARKS: * N°2 OIL 9824 ; RECLAIMED OIL F.S.: 1

PREPARED BY: Rodney G. Phillips

DATE: 15 Oct 95

APPROVED BY:

DATE:

POST ENG

SEE REVERSE SIDE FOR INSTRUCTIONS

FORM 3967

MONTH

SEPTEMBER 1995

TUBES CLEANED NUMBER OF TIMES	PREVENT MAINT. CHECK		CHILL WATER M/U
(20)	(21)	(22)	(23)
6	FU		2700
6	DR		3000
6	FU		2800
6	DR		2600
6	FU		4100
6	DR		3300
6	FU		2200
6	DR		3200
6	FU		2400
6	DR		2600
6	FU		2900
6	DR		2700
6	FU		2900
6	DR		3600
6	FU		2600
6	DR		2600
6	FU		3000
6	DR		3100
6	FU		3000
6	EB		3600
6	DR		2700
6	FU		2600
6	FU		3100
6	FU		3800
6	FU		3600
6	DR		2200
6	DR		2900
6	DR		3000
6	RS		2700
6	RS		2500
180			87,900
6			4100
6			2200
6			2930

L,906

NEER

DATE

A.5-66

A.5-67

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: AUGUST 1995

DATE	STEAM PRESSURE	STEAM PRODUCED: BOILER 1	BOILER 2-3	BOILER 4	TOTAL	WOOD TONS	NO. 2 OIL FUEL USED GAL. *	NAT GAS	OUTSIDE TEMP. AV.	FEEDWATER HEATER PRESS.	FEEDWATER HEATER TEMP.	MAKEUP GAL.	%CO2 BOILER 1	%CO2 BOILER 2-3	%CO2 BOILER 4	FLUE GAS TEMPERATURE BOILER 1	FLUE GAS BOILER 2-3	FLUE GAS BOILER 4	TEMP. H.W. SUPPLY	TUBES CLEANED NUMBER OF TIMES	PREVENT MAINT. CHECK		CHILL WATER
	LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.			°F.	LB.	°F.					°F.	°F.	°F.	°F.				m/u
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1	200			1958	1958	201	159	5000	79			8710			7.0			465	375	6	DR		3700
2	200			1963	1963	267	201	36410	80			9470			7.0			465	375	6	CP		4280
3	200	120	120-	1813	2053	236	766	109740	73			9580	7.8	7.8-	7.0	420	420-	465	375	6	EF		3800
4	200			1969	1969	269	124	12010	75			7020			7.0			465	375	6	DR		4000
5	200			1906	1906	261	61	14100	80			10200			7.0			465	375	6	FU		3900
6	200			1859	1859	254	376	22580	80			8420			7.0			465	375	6	DR		3800
7	200			1884	1884	247	736	14300	80			10430			7.0			465	375	6	FU		4100
8	200			1920	1920	259	300	16340	80			7210			7.0			465	375	6	DR		3600
9	200			1891	1891	228	142	22080	72			5910			7.0			465	375	6	CP		2200
10	200			1861	1861	254	297	103010	74			7260			7.0			465	375	6	EF		2600
11	200			1862	1862	244	700	24100	82			6470			7.0			465	375	6	FU		2700
12	200	440	440-400	519	1799	71	536	752600	87			8320	7.8	7.8-7.8	7.0	420	420-420	465	375	6	DR		4200
13	200	180	176-103	1439	1898	188	515	289360	85			6970	7.8	7.8-7.8	7.0	420	420-420	465	375	6	FU		2600
14	200			1841	1841	248	280	1110	85			6640			7.0			465	375	6	DR		2600
15	200			1780	1780	240	254	4000	81			8410			6.0			465	375	6	FU		3400
16	200			1847	1847	252	100	18020	83			7340			6.0			465	375	6	CP		2840
17	200			1832	1832	247	348	9640	90			6900			6.0			465	375	6	EF		3260
18	200			1826	1826	234	910	9280	91			7630			6.0			465	375	6	DR		3800
19	200			1808	1808	242	487	13300	80			6560			6.0			465	375	6	FU		3400
20	200			1820	1820	239	600	11440	77			5820			6.0			465	375	6	DR		2900
21	200			1809	1809	247	147	6900	78			8020			6.0			465	375	6	FU		3000
22	200			1770	1770	240	190	2200	78			5420			6.0			465	375	6	DR		3100
23	200			1814	1814	201	1122	9260	75			5720			6.0			465	375	6	CP		2900
24	200			1855	1855	136	2054	30580	73			6840			6.0			465	375	6	EF		2300
25	200		160	1837	1997	128	2500	169400	74			10490		7.8	6.0		420	465	375	6	FU		3800
26	200		225	1778	2003	199	1890	237510	75			7220		7.8	6.0		420	465	375	6	DR		1600
27	200		600	1756	2356	240	121	517000	84			8840		7.8	6.0		420	465	375	6	FU		3000
28	200		475	1616	2091	219	160	523420	78			8430		7.8	6.0		420	465	375	6	DR		2800
29	200		575	1738	2303	233	370	450,000	78			7290		7.8	6.0		420	465	375	6	FU		2800
30	200		500	1657	2157	202	1445	379580	77			6740		7.8	6.0		420	465	375	6	EF		2200
31	200	60	408-58	1508	2034	165	2334	518030	76			6930	7.8	7.8-7.8	6.0	420	420-420	465	375	6	CP		2500
TOTAL	6200	800	1144-3096	54736	59766	6891	20225	4,342,220	2382			237210	31.2	31.2-70.2	200	1690	1680-3780	14415	11625	186			101,380
MAXIMUM	200	440	440-600	1969	2356	269	2500	752600	91			10490	7.8	7.8-7.8	7.0	420	420,420	465	375	6			4280
MINIMUM	200	60	120-58	519	1770	71	61	2200	72			5320	7.8	7.8-7.8	6.0	420	420,420	465	375	6			1600
AVERAGE	200	200	286-344	1766	1928	222.3	652.4	140072	77			7652	7.8	7.8-7.8	6.4	420	420,420	465	375	6			3270

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2481; OIL: 112; NAT GAS: 179

REMARKS: * No. 2 OIL: 13,671; RECLAIMED OIL FS.: 6554

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Rodney D. Phillips

DATE: 10 Sep 95

APPROVED BY

DATE

POST ENGINEER

DATE

DA FORM 3967, 1 NOV 72. REPLACES DA FORM 5-90, 1 JUN 58, WHICH WILL BE USED

A.5-68

FACIL S ENGINEERING OPERATING LOG *(Boiler Plant)*
For use of this form, see AR 420-49; the proponent agency is USACE.

INSTAL EADQUARTERS FORT STEWART
FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO: 1412 | MONTH: JULY 1995

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2/3 1,000 LB. (3)	BOILER 4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS 1,000 LB. (6)	No 2 OIL FUEL USED GAL. * (7)	NAT GAS (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	2/3 (14)	4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	2/3 °F. (17)	4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	CHILL WATER MAKE UP (23)
1	200	453	400/97	512	1502	79	479	566010	75			4430	8.0	8.2/8.2	8.4	420	420/420	465	378	1	WB		700
2	200			1295	1295	138	201	18570	73			10620			8.0			465	378	6	EF		1600
3	200			1233	1233	170	424	18890	74			3470			8.5			465	375	6	EF		400
4	200			1297	1297	179	83	12070	79			6990			8.0			465	378	6	WB		1000
5	200			1294	1294	178	84	20730	81			6240			8.0			465	378	6	RP		3100
6	200			1304	1304	180	424	16700	78			7810			7.6			465	376	6	WB		3600
7	200			1257	1257	173	275	15200	76			7480			7.8			465	376	6	DR		3600
8	200			1261	1261	172	88	20600	77			8010			7.8			465	376	6	DR		3500
9	200			1242	1242	171	105	22480	77			9520			7.8			465	375	6	DR		3800
10	200			1269	1269	171	163	7200	78			8050			7.6			468	377	6	EB		4200
11	200	150	200/	1010	1360	139	238	217620	74			6780	8.0	8.2/	7.8	420	420/	466	378	6	DR		4100
12	200	371	491/	546	1408	25	368	501700	77			9470	8.0	8.2/	7.8	420	420/	465	375	0	RP		3100
13	200	826	36/557	0	1419	0	424	943660	69			4470	8.0	8.2/8.2	0	420	420/420	0	375	0	RP		1200
14	200	524	/500	293	1317	37	183	632020	73			5610	8.0	/8.2	7.9	420	/420	465	378	2	EF		2000
15	200			1293	1293	178	424	3020	75			8480			8.1			465	378	6	EF		2700
16	200			1272	1272	173	72	4990	79			8390			8.0			465	378	6	EF		2500
17	200			1272	1272	140	262	6710	70			7710			8.0			465	378	6	DR		2000
18	200			1292	1292	173	280	7680	74			7640			8.2			466	378	6	EF		2000
19	200			1447	1447	199	241	7310	76			9320			8.0			465	377	6	WB		2300
20	200			1442	1442	193	315	10470	81			9930			8.0			466	378	6	RP		3300
21	200			1713	1713	236	180	17360	81			9370			8.0			465	378	6	DR		3600
22	200			1804	1804	231	57	4690	82			9080			7.0			465	378	6	FU		3700
23	200			1765	1765	241	132	2400	86			7480			8.0			465	378	6	DR		3300
24	200			1820	1820	247	212	5500	82			9180			7.0			465	378	6	FU		3300
25	200			1535	1535	200	670	29790	80			11360			8.0			465	378	6	DR		3500
26	200			1867	1867	245	90	20800	80			11130			6.5			465	376	6	WB		3500
27	200		/90	1754	1844	212	73	48970	76			20890		/8.2	7.0		/420	465	378	6	EF		2800
28	200		/301	1500	1801	167	2337	21800	78			10420		/8.2	7.0		/420	465	378	6	FU		3500
29	200			1796	1796	220	1608	25350	78			8090			7.0			465	376	6	WB		3200
30	200			1833	1833	219	1920	30400	80			9080			7.0			465	377	6	FU		3800
31	200			1901	1901	210	3054	10900	75			9820			7.0			465	376	6	DR		3800
TOTAL	6200	2324	1167/1545	41119	46135	5316	15466	3381870	2394			265320	40.0	32.8/48.8	2388	2100	1680/2100	13911	11691	165			88,700
MAXIMUM	200	826	491/557	1901	1901	247	3054	943660	86			20890	8.0	8.2/8.2	8.5	420	420/420	468	378	6			4200
MINIMUM	200	150	36/90	293	1242	25	57	2480	69			4430	8.0	8.2/8.2	6.5	420	420/420	0	375	0			400
AVERAGE	200	588	292/309	1371	1489	171	499	109093	77			9344	8.0	8.2/8.2	7.7	420	420/420	449	377	5.3			2861

EVAPORATION LB. STEAM PER LB. STD. FUEL
.36

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1914; OIL: 86; N.G.: 139

REMARKS: * No 2 OIL: 4851; RECLAIMED OIL F.S.: 10615.

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Rodney G. Phillips | DATE: 8 AUG 95 | APPROVED BY: | DATE: | POST ENGINEER: | DATE:

DA FORM 3967, 1 NOV 72 REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-69

FAC__IES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INST__ION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP | BLDG. NO: 1412 | MONTH: June 1985

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. (6) WOOD	#2 FUEL USED LB. M.C.F. GAL. (7)	N.G EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. W/O (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 4 7.6 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER 4 465 (18)	TEMP H.W. SUPPLY 375 (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 O/S (22)	CWMA (23)
1	200			1265	1265	173	74	16430	84	0		7500			7.5			465	375	6	DT	10	1600
2	200			1274	1274	173	112	5360	84	0		6180			7.5			465	375	6	Pd	15	1605
3	200			1263	1263	138	3056	8590	84	1994		5920			7.5			465	376	6	CCP	163	1045
4	200			1282	1282	113	3356	22,050	82	3482		8410			7.5			465	376	6	CCP	459	1217
5	200	484		1052	1536	96	2528	[illegible]	81	-0-		7600	11		7.5	420		465	375	6	EJ	334	1000
6	200	240		1221	1461	148	1130	174,360	86	-0-		9190	11		7.5	420		465	376	6	CCP	149	1252
7	200			1398	1398	185	427	12,910	91	0		8430			7.5	~~420~~		465	376	6	DT	58	1050
8	200			1427	1427	194	144	0	91	0		5840			7.5	~~420~~		465	376	6	DT	58	1000
9	200			1351	1351	183	111	0	92	0		5910			7.5			465	376	6	EJ	15	1100
10	200			1415	1415	194	975	17,100	86	0		5520			7.5	~~420~~		465	376	6	CCP	37	825
11	200			1370	1370	129	172	13,569	89	0		8310			7.5	~~420~~		465	376	6	DT	22	1155
12	200	~~844~~		421	1265	41	926	443120	88	0		9230	11		7.5	420	420	465	375	6	Dr	122	1300
13	200	348	348	635	1331	87	629	425300	79	0		11450	11	11	7.5	420	420	465	375	6	RP	86	2000
14	200			1384	1384	188	156	2608	78	0		6480			7.8			420	377	6	W	21	1300
15	200			1363	1363	186	100	10640	78	0		5440			7.5			420	377	6	RP	13	1600
16	200			1380	1880	190	121	4420	78	0		7380			7.7			422	378	6	Schine	14	1700
17	200			1294	1294	178	131	5440	79	0		8080			7.6			465	376	6	W	17	1400
18	200			1299	1299	178	100	9140	77	0		7860			7.5			465	377	6	EJ	14	1500
19	200			1311	1311	181	8	10,440	79	0		5700			7.5			465	375	6	EJ	1	1000
20	200			1321	1321	182	35	11480	79	0		5630			7.4			465	375	6	MW	5	1200
21	200			1328	1328	188	25	18370	79	0		6830			7.5			465	380	6	W	3	1500
22	200			1298	1298	174	270	11,160	84	0		9310			7.5			465	380	6	OP	36	2400
23	200			1383	1383	190	141	14766	84	0		9960			7.5			465	375	6	EJ	19	1700
24	200			1306	1306	177	170	17755	85	0		7900			7.5			465	375	6	DT	21	1400
25	200			1352	1352	179	184	4750	86	0		7090			7.8			465	375	6	Dr	21	1600
26	200			1302	1302	178	40	15550	80	0		6240			7.6			465	375	6	EJ	5	1100
27	200			1303	1303	161	132	14730	79	0		8960			7.6			465	375	6	Dr	17	1300
28	200			1397	1397	179	760	7530	72	0		9520			7.6			465	375	6	OPO	100	1600
29	200			1391	1391	183	428	14400	75	0		7460			8.0			466	378	6	WJ	56	1700
30	200	697	666	240	1603	19	100	[illegible]	75	0		4920	7.8	7.8	7.6	420	420	465	377	6	W	13	1400
31							16942	501400															
TOTAL	6000	2613	1014	37026	40653	4768	~~7306~~	2,081,340	2459	5476		224234	39.0	15.6	228	2100	1260	13960	11250	180		2004	41544
MAXIMUM	200	844	666	1427	1603	194	3756	501400	92	3482		11450	7.8	7.8	8.0	420	420	465	380	6		459	2400
MINIMUM	200	240	348	240	1263	19	8	1160	72	1994		4920	7.8	7.8	7.4	420	420	420	375	6		1	825
AVERAGE	200	523	507	1234	1355	159	565	69391	82	2438		7475	7.8	7.8	7.6	420	420	460	375	6		67	1,385

EVAPORATION LB. STEAM PER LB. STD. FUEL: 40653

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-70

#1 70% ...

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft. Stewart | PLANT: CEP | BLDG. NO.: 1412 | MONTH: MAY - 1995

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEEDWATER TO BOILER 1,000 LB. (6)	No. 2 FUEL USED GAL. OIL (7)	N.G. EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER W/O (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	% CO2 BOILER 1 (13)	BOILER 2 (14)	BOILER 4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER 4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	No. 4 015 (22)	CWMU (23)
#4 1	200			1231	1231	168	103	21920	86°	-0-		5980			7.5			465	375	6	CCP	74	6100
2	200			1177	1177	157	295	22817	76.5	0		6010			7.5			465	375	6	CCP	39	9000
3	200			1244	1244	172	159	4040	71	0		8030			7.5			465	375	6	DT	21	10,200
4	200			1318	1318	182	112	3230	71	0		5320			7.5			465	375	6	MW	15	9200
5	200			1231	1231	168	1099	5060	83	0		4060			7.5			465	375	6	ET	13	5100
6	200			1226	1226	167	117	20940	75°	0		4220			7.5			465	375	6	CCP	16	1100
7	200			1214	1214	165	138	9880	78	0		3010			7.5			465	375	6	ET	19	700
8	200	74.4	111.6	1043	1229	187	397	95900	82	0		6450			7.5			465	375	6	CCP	53	800
9	200	—	—	1229	1229	166	219	1190	82	0		3750			7.5			465	375	6	ET	29	500
10	200			1188	1188	165	199	12050	84	0		8950			7.5			461	375	6	DT	27	1100
11	200			1222	1222	164	1026	6440	77	0		8110			7.5			460	375	6	D	4	900
12	200			1193	1193	160	1000	10210	85	3223		8800			7.5			466	375	6	RP	396	900
13	200			1192	1192	176	1000	5510	85	2238		6440			7.5			465	375	6	ET	275	900
14	200			1189	1189	154	1000	7720	89	3516		10,390			7.5			465	375	6	CCP	432	1140
15	200			1027	1027	175	1083	72710	87	2347		2290			7.5			465	375	6	MW	219	550
16	200			1228	1228	169	1008	6290	88.8	-0-		11,300			7.5			465	375	6	CCP	1	2340
17	200			1187	1187	163	1100	9800	87	0		7640			7.5			465	375	6	DT	13	1150
18	200			1193	1193	162	1120	22260	89	-0-		5,090			7.5			465	378	6	MW	15	800
19	200			1170	1170	180	1078	6370	85	-0-		7,570			7.5			465	378	6	[illegible]	10	1000
20	200			1210	1210	166	1053	103770	76	0		7450			7.5			465	377	6	DT	7	1100
21	200			1182	1182	163	1266	3500	74	-0-		7700			7.5			465	376	6	CCP	9	2460
22	200			1230	1230	167	144	5120	76	-0-		6610			7.5			465	375	6	ET	7	1730
23	200			1265	1265	170	257	7783	74.8	-0-		5550			7.5			465	376	6	CCP	34	1750
24	200			1273	1273	175	194	1,820	73	0		7630			7.5			461	376	6	DT	26	940
25	200			1251	1251	172	395	10680	81	-0-		8210			7.5			461	378	6	MW	4	2200
26	200			1222	1222	188	1000	19,100	81	-0-		4450			7.5			465	376	6	CCP	-0-	1810
27	200			1225	1228	165	164	12,600	87	-0-		6478			7.5			465	375	6	ET	21	800
28	200			1196	1196	182	168	12785	81	-0-		8600			7.5			465	376	6	CCP	22	1160
29	200			1263	1263	189	261	9355	87	-0-		6160			7.5			465	376	6	ET	34	540
30	200			1295	1295	180	452	9660	88.8	-0-		7890			7.5			405	375	6	CCP	60	1100
31	200			1274	1274	185	292	7610	83	0		5790			7.5			405	375	6	DT	39	500
TOTAL	6200	74.4	111.6	37588	37774	5322	17849	550120	2520	11324		206660			232.6			14415	11625	186		1906	69,620
MAXIMUM	200	74.4	111.6	1318	1318	189	1266	103770	89	3516		11300			7.5			465	375	6		432	10,200
MINIMUM	200	74.4	111.6	1027	1027	154	103	1830	71	2238		2290			7.5			465	375	6		1	500
AVERAGE	200	74.4	111.6	1213	1219	172	576	17746	81	2831		6661			7.5			465	375	6		61	2244

EVAPORATION LB. STEAM PER LB. STD. FUEL | FUEL USED DURING MONTH (STANDARD TONS) | REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS | PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 9-98 1 JUN 55, WHICH WILL BE USED.

A.5-70

A.5-71

#1 40% #2 60% of load

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: FT. STEWART | PLANT: CEP | BLDG. NO.: 1412 | MONTH: APR-95

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS (6)	NO 2 FUEL USED GAL. OIL (7)	N.G. (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER W/O (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	% CO2 BOILER 1 (13)	% CO2 BOILER 2 (14)	% CO2 BOILER 4 (15)	FLUE GAS TEMP. BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER 4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 O/S (22)	CWMU (23)
#H 1	200	179	249	#4 904	1332	117	20	303,600	59	—		14330	7.4	7.4	7.4	420	420	420	380	2	[illegible]	55	300
2	200	516	770		1286	-0-	-0-	824,230	57	-0-		9,910	7.4	7.4		420	420		380	0	[illegible]	-0-	500
3	200	611	816		1427	-0-	-0-	866,400	60	-0-		11,410	7.4	7.4		420	420		380	0	[illegible]	-0-	400
4	200	645	675		1320	-0-	-0-	853920	66	-0-		11,550	7.4	7.4		420	420		380	0	[illegible]	-0-	500
5	200	666	664		1332	0	0	957920	58	0		9583	7.4	7.4		420	420		380	0	TW	0	500
6	200	693	695		1388	0	0	898878	56	0		12550	7.4	7.4		420	420		380	0	TW	0	800
7	200	579	649		1228	-0-	-0-	864,200	62	0		9140	7.4	7.4		420	420		380	0	[illegible]	0	800
8	200	591	633		1224	0	0	898872	64	0		10320	7.4	7.4		420	420		380	0	[illegible]	0	900
9	200	599	606		1206	0	0	898872	67	0		10890	7.4	7.4		420	420		380	0	[illegible]	0	500
10	200	566	581		1147	0	0	898878	68	0		10460	7.4	7.4		420	420		380	0	[illegible]	0	800
11	200	549	604		1153	0	0	710,020	71	0		7,720	7.4	7.4		420	420		380	0	[illegible]	0	800
12	200	549	576		1125	0	0	686300	74	0		7553	7.4	7.4		420	420		380	0	TW	0	400
13	200	603	620		1223	0	0	715000	75	0		11,020	7.4	7.4	7.4	420	420	420	380	0	TW	0	400
14	200	570	587	#4 62	1219	0	26	696120	70	0		10,580	7.4	7.4		420	420		380	0	[illegible]	62	500
15	200	585	600		1185	0	0	717,150	74	0		6900	7.4	7.4		420	420		380	0	[illegible]	0	300
16	200	558	614		1172	0	0	666300	79	0		8440	7.4	7.4		420	420		380	0	[illegible]	0	200
17	200	369	376	#4 391	1136	44	52	458,440	81	0		7340	7.4	7.4	7.0	420	420	420	380	6	[illegible]	44	450
18	200			1025	1025	135	43	6650	81	0		8490			7.4			465	388	6	W	8	350
19	200			904	904	115	46	10230	80	0		8670			7.4			465	388	6	TW	6	800
20	200			930	930	127	35	1840	80	0		97910			7.4			465	380	6	DT	9	200
21	200			895	895	100	35	0	83	0		7960			7.4			465	380	6	Br	5	300
22	200			870	870	93	35	1,120	84	0		10988 40			7.4			465	380	6	DT	9	500
23	200			890	890	106	25	240	84	0		8580			7.4			465	380	6	MW	13	100
24	200			870	870	93	26	6490	78	0		10600			7.4			465	378	6	W	34	400
25	200			1163	1163	151	65	2900	65	0		7940			7.4			465	328	6	TW	63	48,000
26	200			1246	1246	165	28	7850	70	0		5746			7.4			465	375	6	DT	47	6560
27	200			1216	1216	168	27	5080	76	0		6800			7.4			465	375	6	Br	16	5800
28	200			1143	1143	155	24	15400	62	0		10640			7.4			465	375	6	DT	14	5400
29	200			1223	1223	156	35	11,260	77	0		7840	-	-	7.4			465	375	6	CCP	90	7000
30	200			1213	1213	166	24	4420	85	0		5480			7.4			465	375	6	[illegible]	7	5800
31																							
TOTAL	6000	9828	10315	14946	34688	1869	550	12,996,580	2138	0		264018	125.8	125.8	118.4	7140	7140	7305	11400	86		76	90800
MAXIMUM	200	693	695	1246	1427	168	65	957980	85	0		12550	7.4	7.4	7.4	420	420	465	380	6		63	48000
MINIMUM	200	179	249	62	870	44	20	240	56	0		5480	7.4	7.4	7.4	420	420	420	380	2		3	100
AVERAGE	200	555	607	934	1156	125	34	433173	71	0		8803	7.4	7.4	7.4	420	420	457	380	6		6	3027

EVAPORATION LB. STEAM PER LB. STD. FUEL: MLLL =

FUEL USED DURING MONTH (STANDARD TONS): 41626 20551 78 13268

REMARKS: 274470

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 1 NOV 72 3967 REPLACES DA FORM 8-08 1 JUN 58 WHICH WILL BE USED.

A.5-71

A.

A.5-72

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft. Stew | PLANT: CEP | BLDG. NO.: 1412 | MONTH: MAR 95

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 1/2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS (6)	FUEL USED #2 GAL. (7)	N.G. (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER W/O (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	% CO_2 BOILER 4 (13)	BOILER (14)	BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	BOILER °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 O/S (22)	CWMU (23)
1	200	1646			1646	204	1228	2980	63	—		18680	7.4			422			374	6	WB	162	2900
2	200	1756			1756	197	2855	14970	52	—		13870	7.4			422			375	6	ELB	324	400
3	200	1760			1760	238	263	3620	58	—		7820	7.4			422			373	6	W	35	300
4	200	1709			1709	228	422	2910	58	—		11000	7.4			422			375	6	D.T	56	200
5	200	1681			1681	207	681	10740	55	—		13170	7.4			422			378	6	W	82	400
6	200	1568			1568	211	293	3600	65	—		10400	7.4			422			375	6	DT	39	100
7	200	1506			1506	193	804	8380	68	—		9140	7.4			422			375	6	W	106	200
8	200	1443			1443	199	208	15800	60	—		11970	7.4			422			376	6	[illegible]	20	300
9	200	1700			1700	222	710	8190	43	—		14280	7.4			429			375	6	ELB	94	300
10	200	1523			1523	123	2072	5600	43	—		7520	7.4			429			375	6	DT	293	300
11	200	1707			1707	202	1821	203980	49°			11,230	7.4			423			375	6	CCP	240	300
12	200	1523			1523	196	1150	6200	59	—		14,300	7.4			422			375	6	DT	182	500
13	200	1475			1475	179	1304	1936	59	—		12,910	7.4			422			375	6	DT	122	300
14	200	1497			1497	197	514	11640	58	—		9,520	7.4			422			375	6	DT	68	500
15	200	1385			1385	178	700	14070	62	—		12110	7.4			422			378	6	[illegible]	92	600
16	200	1362			1362	187	157	12130	59	—		11250	7.4			422			375	6	DR	19	600
17	200	1400			1400	181	704	9690	66	—		13110	7.4			422			375	6	DT	93	900
18	200	1407			1407	194	1007	8010	58	—		9570	7.4			422			375	6	[illegible]	-0-	500
19	200	1414			1414	190	288	13950	55	—		9070	7.4			420			378	6	W	38	500
20	200	1469			1469	185	966	41550	61	—		8530	7.4			422			375	6	[illegible]	127	400
21	200	1372			1372	186	191	9250	69	—		9400	7.4			422			376	6	W	25	600
22	200	1368			1368	174	876	8900	70	876		13230	7.4			422			378	6	ZW	108	1200
23	200	1328			1328	134	2866	8100	72	2865		12560	7.4			422			380	6	[illegible]	352	1800
24	200	1231			1231	108	3599	11060	63	3599		14,620	7.4			422			380	6	[illegible]	442	2400
25	200	1320			1320	131	3004	13900	59	3004		11200	7.4			421			378	6	W	369	1900
26	200	1321			1321	161	1442	14320	59	1232		13030	7.4			422			378	6	[illegible]	179	1500
27	200	1310			1310	180	22	7400	65	—		11740	7.4			422			377	6	W	3	1100
28	200	1328			1328	182	30	14170	71	—		12100	7.4			422			377	6	[illegible]	4	1900
29	200	1316			1316	180	67	4400	62			10120	7.4			422			378	6	[illegible]	8	1100
30	200	1252			1252	168	240	15980	67	—		8060	7.4			422		-	375	6	DT	31	700
31	200	1264			1264	158	897	16050	52	—		14580	7.4			422			376	6	W	118	300
TOTAL	6200	46,611			45611	5723	30980	518870	1858	11576		360940	229.4			13082			11625	186		3831	25500
MAXIMUM	200	1760			1760	238	3599	203,980	72	3599		14680	7.4			422			380	6		324	2900
MINIMUM	200	1231			1231	108	22	1936	43	1232		7520	7.4			422			372	6		3	100
AVERAGE	200	1471			1471	185	593	16916	60	2315		11,643	7.4			422			375	6		124	823

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2060; OIL: 172; N.G. 21

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: 54733 62757 4368 530 | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 8-88 1 JUN 58 WHICH WILL BE USED.

54733 ÷ 67411 - 81? .81

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft Stewart | PLANT: CEP | BLDG. NO. 1412 | MONTH: FEB. 95

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 1/2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD WATER TO BOILER 1,000 LB. (6)	#2 FUEL USED LB. M.C.F. GAL. (7)	NG (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. W/O (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	% CO2 BOILER 4 (13)	% CO2 BOILER 1 (14)	% CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	FLUE GAS BOILER 1 °F. (17)	FLUE GAS BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 O/S (22)	CWMU (23)
1	200	1860			1860	228	1545	16840	47°	-0-			74N	opr.	-	400	opr.	-	378	6	CCP	203	355
2	200	1740			1740	222	1325	10610	56	717			7.4			422			376	6	EJ	131	945
3	200	1634			1624	150	8100	33840	62	1982		14990	7.4			422			376	6	JH	244	340
4	200	1555		223	1778	166	8550	20,100	49	2846		16660	7.4			422		420	376	6	JH	346	10
5	200	898		805	1703	94	9003	1900	44	1506		16,630	7.4			422		420	376	6	DT	218	0
6	200	954		1014	1968	132	11,336	0	37	—		12940				422		420	373	6	W	0	200
7	200	105	598	1108	1811	27	11250	361990	47	—		17370	#1	7.4	7.4	422	385	420	374	6	W	—	700
8	200	[illegible]	400/400	758	1558	—	11220	0	36	—		17540	7.4	7.4	7.4	[illegible]	385	420	372	6	[illegible]	—	
9	200	"	500/500	948	1948	—	11305	0	35	—		15240	"	"	"	[illegible]	"/385	420	374	6	Dn	—	760
10	200	70	500/500	870	1940	11	19745	0	50			17320	7.4	7.4	7.4	422	385	420	376	6	W	40	700
11	200	1640	180		1820	196	1356	14880	58	1433		15500	7.4	7.4		428	385		374	4	W	225	200
12	200	1862			1862	193	1621	4236	49	4737		14920	7.4			422			373	6	W	597	300
13	200	1967			1967	242	1613	122,484	48	0		11,426	7.4			428			374	6	DT	213	200
14	200	1957			1957	252	2001	3830	50	—		18050	7.4			422			372	6	W	132	900
15	200	1919			1919	265	1989	11,640	59	—		25150	7.4			422			374	6	CCP	131	800
16	200	1584			1584	219	1255	16,760	73	—		14,280	7.4			422			376	6	CCP	37	330
17	200	1569			1569	205	1600	5700	64	—		12,940	7.4			428			373	6	JH	80	270
18	200	1760			1760	222	1600	0	50	—		11130	7.4			422			374	6	W	745	200
19	200	1854			1854	212	2402	15,380	48	—		17920	7.4			422			374	6	DT	317	200
20	200	1858			1858	220	2000	27710	58	—		11550	7.4			422			373	6	W	264	100
21	200	1849			1849	218	2004	38580	47	—		15790	7.4			422			373	6	DT	264	300
22	200	2041			2041	281	1659	20080	39	—		13680	7.4			422			373	6	EB	218	300
23	200	1949			1949	268	1259	30	48	[illegible]		9050	7.4			422			373	6	JH	166	300
24	200	1891			1991	272	1542	1730	51	[illegible]		6540	7.4			422			374	6	W	203	300
25	200	1970			1970	252	2020	0	47	-		8290	7.4			422			374	6	DT	142	200
26	200	1851			1851	229	1407	15280	50			7870	7.4			412			376	8	W	176	300
27	200	326	1000		1326	34	1581	403080	57	—		24220	7.4			422	385		376	6	DT	77	300
28	200	1819			1819	234	1930	80	65	—		12030	7.4			422			373	6	W	122	800
29																							
30																							
31																							
TOTAL	5600	40372	3178/1440	5726	50776	5024	223,592	1159780	1426	13181		383346	192	37	296	10972	2310/1160	2940	10488	168		14712	10,010
MAXIMUM	200	2041	1000/500	1108	2041	281	19,145	403080	73	4732		25150	7.4	7.4	7.4	422	385/385	420	378	6		597	945
MINIMUM	200	70	180/400	223	1326	11	1255	30	35	717		6540	7.4	7.4	7.4	422	385/385	420	372	6		40	10
AVERAGE	200	1557	230/467	818	1813	193	4,414	52715	51	2197		14745	7.4	7.4	7.4	422	385	420	375	6		669	385

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-88 1 JUN 55 WHICH WILL BE USED.

A.5-73

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft. Stewart | PLANT: CEP | BLDG. NO.: 1412 | MONTH: JAN. 95

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 1 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD 1,000 LB. (6)	#2 FUEL USED (7)	N.G. (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. W/O (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	% CO2 BOILER 4 (13)	% CO2 BOILER 1 (14)	% CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	FLUE GAS BOILER 1 °F. (17)	FLUE GAS BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 O/S (22)	CWMU (23)
1	200		800	1015	1815	—	9,253	—	53	—		12340	—	11	11	420	420	420	380		DR	—	1300
2	200	1[illegible]	800	1048	1844	—	9,253	50	50	—		14200	—	11	11	420	420	420	380		DR	—	700
3	200	353	800	700	1753	49	44 724	—	46	-0-		11070	11	11	11	420	420	420	380		DJ	96	200
4	200	1974	—	—	1974	230	2285	2480	41	-0-		16470	11	—	—	420	—	—	380		EF	301	1100
5	200	1824	—	—	1824	231	1104	10140	37	-0-		14790	11	"	"	420	—	—	380		CCP	146	800
6	200	1848	—	—	1848	239	810	9660	50	—		8750	"	"	—	44	—	—	380		DR	107	1200
7	200	1550	—	—	1550	207	856	11362	56	—		11670	11	—	—	420	—	—	380		ZH	47	1200
8	200	1826	—	—	1826	249	1120	13280	42			11310	"	—	—	420	—	—	380		DR	16	400
9	200	1896			1896	243	852	22760	48			10650	11	—	—	420	—	—	380		TL	61	400
10	200	1792	—	—	1792	224	1220	7340	51			12070	11	—	—	420	—	—	380		DR	161	1200
11	200	1705			1705	220	809	1630	54	-0-		8370	11	—	—	420	—	—	380		EF	107	500
12	200	1592			1592	220	1415	19180	55	-0-		10090	"	—	—	420			380		CCP	55	500
13	200	1512			1592	173	1980	56[illegible]	64	0		15170	11	—	—	420	—	—	380		TL	260	1500
14	200	1430	108		1538	180	720	90490	63	—		13320	"	—	—	420	—	—	380		DR	95	300
15	200	1185		444	1629	152	591	132,320	68	—		15450	11		11	420		420	380		TL	78	400
16	200	1436		234	1670	185	670	128,000	53			15060	11		11	460		420	380		TL	88	600
17	200	1683			1683	203	1559	31240	54			15040	11		—	460		—	380		TL	206	700
18	200	1734			1734	201	1427	27620	52	1781		13900	11		11	460		420	380		EJ	275	1100
19	200	1530			1530	138	-0-	80,070	59	4321		17980	"		"	460		420	380		CCP	530	1570
20	200	1837			1837	206	—	7560	49	2789		14010	"		"	466		420	380		DR	342	300
21	200	1842			1842	249	1241	1200	50	—		9440	11		—	4[illegible]			380		TL	31	100
22	200	1810			1810	247	1120	13060	48	—		12120	"	—	—	460			380		DR	16	100
23	200	1712	60	50	1822	222	759	48300	46	—		16140				460	420	420	380		ZH	106	100
24	200	1955			1955	246	730	57670	40	—		13080				460			380		DR	97	0
25	200	2004			2004	259	1403	17870	40			14830				460			380		EJ	54	100
26	200	1902	—	—	1902	212	1368	29360	46	—		13280				460			380		CCP	49	-0-
27	200	1854			1854	250	1306	31500	52			14763				460			380		TL	41	200
28	200	1434		216	1650	195	470	70,700	60			11050				460			380		TL	62	600
29	200	1565		216	1781	200	895	83400	59			11390				460			380		DT	118	800
30	200	1825			1825	237	1190	40500	46			11220				460			380		TL	157	300
31	200	1952			1952	243	1430	47,180	43			13900				460			380		DR	189	200
TOTAL	6200	48612	2468	3923	55003	6,100	48592	1,027,800	1565	8891		403,424				13220	1680	3780	11780			3891	18470
MAXIMUM	200	2004	800	1048	2004	259	9,253	132,320	64	4321		17980				480	420	420	380			530	1570
MINIMUM	200	353	60	50	1512	49	591	50	37	1781		8370				420	420	420	380			16	100
AVERAGE	200	1676	494	490	1774	210	1675	35442	50	2963		13013				428	420	420	380			134	636

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 55, WHICH WILL BE USED.

A.5-74

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: FT. STEWART | PLANT: CEP | BLDG. NO. 1412 | MONTH: Dec 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED WATER TO BOILER 2,000 LB. (6)	No.2 FUEL USED GAL. (7)	N.G. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. W/O (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	[illegible] BOILER 4 (13)	2 (14)	3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	2 °F. (17)	3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	NO. 4 O/S (22)	CWMU (23)
1	200	1324			1324	231	1548	43100	49	3029	220	16310	11			435			382	6	OHP	372	5700
2	200	1775			1775	288	1548	25650	59	2447	220	17750	11			435			380	6	DT	300	5100
3	200	1276			1276	220	821	30710	63°	—	220	12720	11			435			381	6	ELB	43	4700
4	200	1134			1134	257	831	44010	70	—	220	13390				435			381	6	DT	44	4400
5	200	1186			1186	214	736	74500	69°	2129	220	16600				435			386	6	Bn	359	4200
6	200	1315			1315	182	1548	13350	67°	3029	220	18870				435			380	6	Bn	372	3700
7	200	1397			1397	176	1092	18150	62	883	220	10970				435			380	6	EZ	122	3900
8	200	1349			1349	181	1278	20080	63	—	220	11670				435			380	6	PHP	37	3900
9	200	1411			1411	188	355	20300	60°	—	220	10380				435			379	6	ELB	47	1600
10	200	1400			1400	193	1049	6990	62	—	220	14540				434			380	6	Bn	7	0
11	200	1518			1518	199	598	8950	53	—	220	11660				435			380	6	Bn	79	0
12	200	1654			1654	228	401	34100	43	—	220	15580				435			380	6	Bn	53	700
13	200	1810			1810	229	1145	23040	46	—	220	8080				435			377	6	ELB	151	200
14	200	1680			1680	232	457	17260	47		220	10740				434			375	6	W	61	1100
15	200	1727			1727	226	725	21840	51	—	220	10810	11			435			375	6	DT	96	400
16	200	1767			1767	230	751	22000	47	—	220	13500				435			375	6	GHP	99	300
17	200	1649			1649	223	1256	18880	49	—	220	10170	11			435			375	6	ELB	34	300
18	200	1589			1589	219	1243	14960	52	—	220	10410	11			435			375	6	DT	32	300
19	200	1767			1767	237	362	25530	43°	—	220	10490				435			374	6	ELB	48	100
20	200	1774		[illegible]	1774	245	1102	13660	48	—	220	19250				434			375	6	Bn	14	2100
21	200	1724		198	1922	221	570	73920	49	895	220	19410	11			435			375	6	Bgs	124	2700
22	200	1454		571	2025	160	436	242320	49	1943	220	15300				435			377	6	W	297	2200
23	200	1550		362	1912	211	1157	224830	46	—	220	7830				425			377	6	ELB	20	1000
24	200	1592		181	1773	200	1065	138330	52		220	10840				435			376	6	ZH	141	800
25	200	1784			1784	233	700	14200	48	—	220	12690				435			374	6	Bn	93	1400
26	200	1713			1713	232	1213	2900	52		220	5980				435			375	6	BH	28	1000
27	200	1756			1756	218	1500	21300	51	1929	220	17900				435			375	6	ZZ	237	1300
28	200	1636			1636	175	1596	7130	51	2965	220	16480				435			375	6	EF	364	1700
29	200	803		597	~~[illegible]~~	195	1548	17040	54	947	220	20,800				435			375	6	CCP	116	1500
30	200			1400	1400	243	1500	5150	54	—	220	9500						435	370	6	—	—	600
31	200			1796	1796	243	1596	122690	49	—	220	14520						435	375	6	Bn	—	1100
TOTAL	6200	44,514		5105	49169	6631	31,727	1,366090	1660	20196	6820	419160				12612		870	11691	186		3790	58000
MAXIMUM	200	1784		1796	2025	257	1596	242,370	70	3029	220	20800				435		435	382	6		372	5200
MINIMUM	200	803		181	1134	160	355	2900	43	883	220	7830				434		435	370	6		7	100
AVERAGE	200	1534		729	1600	214	1024	44068	53	2019	220	13521				434		435	377	6		130	2000

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-80, 1 JUN 58 WHICH WILL BE USED.

A.5-75

A.5-76

ACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft Stewart — PLANT: CEP — BLDG. NO. 1412 — MONTH: Nov 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	Wood 1,000 LB. (6)	No 2 FUEL OIL (7)	NG (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRES. LB. W-O.O (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	% CO_2 BOILER 1 (13)	% CO_2 BOILER 4 (14)	% CO_2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 BLR O/S (22)	CWMU (23)
1	300	1188			1188	150	2775	43100	61	705		4120		7.5		421			365	6	EZ	96	5200
2	200	1218			1218	168	2077	70570	55	7-		1910		7.4		422			365	6	DT	10	10300
3	200	1256			1256	172	2257	90	60	—		13180		7.4		422			365	6	MW	100	9700
4	200	1248			1248	160	2612	42830	65	-		16220		7.4		422			365	6	CCP	81	10400
5	200	1241			1241	164	350	4960	70			15080		7.4		422			365	6	PK	86	9100
6	200	1188			1188	160	212	38220	74°			14900		7.5		421			365	6	SCP	28	9800
7	200	1178			1178	156	348	43600	65°			12210		7.5		421			365	6	EZ	46	9000
8	200	1177			1177	159	171	25,260	64°			15,360		7.5		421			365	6	CP	23	9200
9	200	1190			1190	164	215	19,510	70°			18,450		7.5		421			365	6	DT	28	12400
10	200	1100		100	1200	151	1020	56130	73			16470		7.5	7.6	424		420	372	6	DT	135	11800
11	200	1073		379	1452	147	571	230410	54	1412		13860		7.5	7.6	421		420	370	6	W	248	10100
12	200	1298			1298	131	3500	6320	57	2777		14480		7.4		422			370	6	Dn	341	11500
13	200	1433			1433	156	3500	11830	59	2394		13250		7.4		422			370	6	Dn	294	11400
14	200	1415			1415	152	1618	8900	65	2567		19840		7.4		422			368	6	EF	315	9500
15	200	1391			1391	157	2948	22210	67°	2034		22030		7.4		422			368	6	Dn	250	8200
16	200	1248			1248	136	2025	56800	63	2092		11030		7.4		422			374	6	W	261	18000
17	200	1366			1366	183	308	31910	57	—		23,010		7.4		422			374	6	RP	41	7200
18	200	1353			1353	180	373	14960	64	—		12,580		7.4		422			373	6	ELB	50	7600
19	200	1265			1265	175	294	21280	66	—		18870		7.4		422			372	6	DR	39	9200
20	200	1315			1315	180	2081	32080	61	—		12640		7.4		422			373	6	ELB	11	14700
21	200	989.0		266.0	1,255	137	2259	9210	71°	—		14180		7.6	7.6	420		420	374	6	DR	285	5800
22	200	1213			1213	161	327	37060	66°	—		17650		7.4		422			373	6	ELB	43	8900
23	200	1261			1261	154	1078	77830	53	—		18870		7.4		422			373	6	Dn	142	6800
24	200	1312			1312	170	600	- 70	44	—		13150		7.4		422			374	6	EZ	79	6800
25	200	1312			1312	181	229	27300	53	—		12510		7.4		422			374	6	LR	31	2600
26	200	1347			1347	181	261	4910	54	—		13890		7.4		422			374	6	Dn	34	7300
27	200	1300			1300	179	102	23140	65	—		12370		7.4		422			374	6	Dn	13	8500
28	200	1194			1194	136	1533	20340	72	—		14820		7.5		421			375	6	ELB	202	10200
29	200	1210			1210	167	2071	26950	65	1167		13580		7.4		422			374	6	DR	152	9200
30	200	1231			1231	127	1000	29610	54	2532		16470		7.4		422			378	6	W	311	8900
31																							
TOTAL	6000	37510		745	38255	5000	54096	1082080	1867														
MAXIMUM	200	1433		379	1452	183	3500	230410	74			442980		223.0	22.8	12610		1260	11112	180			
MINIMUM	200	989		100	1177	127	102	70	44			23010		7.6	7.6	422		420	378	6			
AVERAGE	200	1250		248	1275	167	1803	36068	62			1910		7.4	7.6	420		410	365	6			
EVAPORATION LB. STEAM PER LB. STD. FUEL												14766		7.4	7.6	421		420	370	6			
	6000	37510		745	FUEL USED DURING MONTH (STANDARD TONS) 38,255	4794	11,840	1,038,930	1867	17680		REMARKS 442,980		223	22.8	12610		1260	11,112	180		3735	290300

SEE REVERSE SIDE FOR INSTRUCTIONS 3

PREPARED BY — DATE — APPROVED BY — DATE — POST ENGINEER — DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-96 1 JUN 58, WHICH WILL BE USED.

+1200
7.4 422
-1200
7.5 421
#3
7.6 420

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: Ft. Stewart | PLANT: C.E.P | BLDG. NO. 1412 | MONTH: Oct. 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	MAKEUP WATER TO BOILER 1,000 LB. (6)	FUEL USED GAL. Oil (7)	N.G EQUIV. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	CO2 BOILER 4 (13)	CO2 BOILER 4 (14)	CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 BLR O/S (22)	Cwmk (23)
1	200	1244			1244	166	287	8170	73	3	223	7050		11		420			384	6	EZ	38	2600
2	200	1248			1248	165	400	30	73	3	217	9190		11		420			384	6	CP	53	3200
3	200	1321			1321	127	W.O.3223	-30	71	3	222	10,300		11		420			383	6	EZ	402	2800
4	200	965			965	85	2864	30	63	3	222	6730		11		420			384	6	CCP	352	2600
5	200	1401			1401	142		30	64	3	224	8520		11		420			384	6	MW	123	2700
6	200	1443			1443	149	550	0	67	3	220	12,550		11		420			384	6	DT	23	2800
7	200	1373			1373	135	203	20	66	3	220	11,210		11		420			383	6	EZ	27	2600
8	200	1383			1383	136	268	110,000	68	3	220	10,010		11		420			384	6	CCP	35	2600
9	200	1406			1406	135	458	10	76	3	220	9920		11		420			385	6	EZ	60	2600
10	200	1295			1295	155	WO/1341	-0-	75	3	220	9460		11		420			385	6	CP	168	2700
11	200	1416			1416	137	WO/3308	-0-	55	3	220	2120		11		420			385	6	EZ	421	2900
12	200	1427	[illegible]	114	1541	.146	WO 2090	0	60	3	220	900		11		420			385	6	DT	257	3150
13	200	1281		492	1773	.127	81	25040	68	3	220	1100		11		420			385	6	DT	81	1600
14	200	1618		364	1982	.106	922	186,620	70.5	3	220	1260		11		420			385	6	CP	122	2500
15	200	1839			1839	.141	683	4570	62	3	223	2440		11		420			382	6	W	90	3100
16	200	1850			1850	.226	1614	0	61.5	3	222	2470		11		420			385	6	CP	213	3200
17	220	1844			1844	.120	1902	57550	60	3	223	1840		11		420			383	6	W	251	2600
18	200	1823			1823	.115	2010	-0-	66.5	3	223	2330		11		420			385	6	CP	266	2300
19	200	1459		209	1668	.101	2755	9770	68	3	223	2140		11		420			365	6	DT	364	2200
20	200	1363			1363	.138	888		74	3	223	1900		11		420			365	6	MW	110	2000
21	200	1328			1328	.124	506	3100	74	3	223	1730		11		420			365	6	CCP	67	2000
22	200	1305			1305	.123	404	-0-	74	3	223	3020		11		420			365	6	EZ	54	1900
23	200	1265			1265	.124	42	-0-	73	3	223	1390		11		420			365	6	CCP	6	2100
24	200	1286			1286	169	421	-0-	69	3	223	2520		11		420			365	6	EZ	63	2000
25	200	1256			1256	160	254	7390	70	3	223	1950		11		420			365	6	CP	100	2000
26	200	800		467	1267	110		14860	66	3	223	2220		11		420			365	6	MW		1600
27	200	800		504	1304	110		—	55	3	223	1830		11		420			365		MW		2800
28	200		[illegible]	1008	1008	-0-	554	134,490	54	3	223	1870						420	365	6	EZ	-0-	2500
29	200	1153	WO	1419	1153	134	1508	10	62.5	3	223	2140		11		420		420	365	6	CP	186	2400
30	200	1166	WO	2877	1166	110	2899	-0-	62	3	223	750		11		420			365	6	EZ	354	2400
31	200	1146	WO	3369	1146	101	3369	10	74	3	223	2500		11		420			365	6	CP	413	1910
TOTAL	6200	40504		3158	43662	3947	25802	598,230	2049			136,384							11160	180			76363
MAXIMUM	200	1850		1008	1982	169	3369	188,620	76			12,550							385				
MINIMUM	200	800		114	1008	85	42	10	54			900							365				
AVERAGE	200	1306.5		452	1408.4	132	1279	29,912	66			4400							376				2463

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS: * No.2 oil 17,027 ; Reclaimed oil 18,775

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-88 1 JUN 58, WHICH WILL BE USED.

965 7.5 421

1200+ 7.4 422

A.5-77

ACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

LATION: FT STEW | PLANT: CEP | BLDG. NO.: 1412 | MONTH: SEP '94'

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WDD FEED-WATER TO BOILER 1,000 LB. (6)	OIL FUEL USED LB. M.C.F. GAL. * (7)	NG EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	% CO2 BOILER 1 (13)	% CO2 BOILER 4 (14)	% CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS TEMPERATURE BOILER 4 °F. (17)	FLUE GAS TEMPERATURE BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 BLR O/S (22)	CWMU (23)
1	200	2015			2015	222	345	0	82	3	223	6740		11			430		382	6	[illegible]	46	3300
2	200	1952			1952	258	556	4170	91	3	223	10850		11			430		382	6	w		3100
3	200	1610			1610	214	430	7050	84	3	225	7990		11			430		384	6	DT	57	3100
4	200	1596			1596	186	120	0	71	3	225	7390		"			430		384	6	DT		2900
5	200	1400		200	1600	156	—	81550	73	3	225	5060		11			43		384	6	DT	274	2900
6	[illegible]	1549		200	1749	196	300	108930	78	3	223	17800		11			430		382	6	[illegible]		3000
7	200	1672		200	1872	209	126	139290	77	3	223	9440		11			430		382	6		151	1900
8	200	1878			1878	241	954	—	78	3	223	10420		"			430		384	6	mw	125	2700
9	220	2003			2063	275	1430	-	75	3	223	8540		11			420		383	6	w	188	2700
10	220	1158		458	1588	119	2640	✓	78	3	225	8200		11			436		383	6		269	2800
11	220	2025			2025	267	1731	-	76	3	225	8060		11			430		382	6	[illegible]	23	3900
12	220	277		1306	1583	0	9222	✓	77	3	226	8320		"			430		383	6	DT	277	1700
13	220			1147	1147	—	8700	330	74	3	223	5600		#	11		4'	430	383	3	w	—	2800
14	200	260		77.8	1038	27	8500	500	76	3	223	2070		11	11		4	430	383	3	w	65	2900
15	206	1199			1199	149	920	0	80	3	223	6840		11			430		383	3	PMP	121	2700
16	200	1275			1275	[illegible]	112	0	86	3	223	6990		—			—		382	3	w	16	2600
17	200	1276			1276	[illegible]	[illegible]	0	78	[illegible]	[illegible]	[illegible]		-			-		381	[illegible]		35	[illegible]
18	200	1342			1342	[illegible]	0	0	78	3	222	6980		-			426		380	3	DT		3000
19	200	1331			1331	240	268	3750	71	3	222	9150		11			420		382	[illegible]	w	36	3000
20	206	1348			1348	178	2425	8	76	3	225	8690		11			420		382	3	DT	70	3100
21	200	1366			1366	171	924	5.	72	3	225	8030		11			420		380	3	[illegible]	121	3200
22	200	1274			1274	167	441	5666	72	3	225	9870		11			[illegible]		384	6	[illegible]	58	2700
23	200	1258			1358	187	297	10	73	3	225	9440		11			420		385	6	DT	39	2800
24	200	1378			1378	179	551	10	72	3	215	9970		11			420		384	6	[illegible]	72	[illegible]
25	200	1305			1305	179	WO 3616	0	80	3	223	1390		11			420		385	6		5	2800
26	200	1280			1280	130	WO 2752	—	80	3	223	5570		.			420		385	6	mw	338	[illegible]
27	206	1284			1254	132	WO 2683	-	75	3	223	9120		11			426		385	6		330	1830
28	200	1305			1305	127	WO 3178	—	76	2	223	10450		11			[illegible]		[illegible]	[illegible]	✓	390	2700
29	200	1288			1288	133	WO 2621	8270	80	3	223	8210		11			420		385	6	[illegible]	332	[illegible]700
30	200	1277			1277	176	WO 2553	0	75	3	222	7970		11			426		385	6	D.T	351	[illegible]700
31																							
TOTAL	[illegible]	110285		4289	44574	4969	58370	352500	2305			246220	7						11492				83833
MAXIMUM	[illegible]	2025		1306	2025	267	8700	139290	91			17800							385				
MINIMUM	[illegible]	260		200	1199	27	120	10	70			1390							380				
AVERAGE	[illegible]	1389		613	1496	177.5	2084.6	29375	77			8207							383				

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS
*

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 5-90 1 JUN 55 WHICH WILL BE USED.

A.5-78

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313
PLANT: CEP
BLDG. NO.: 1412
MONTH: Aug 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 (W/O) 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD 1,000 LB. (6)	NO. 2 FUEL USED LB. M.C.F. GAL. OIL (7)	N.G. (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMP. BOILER 1 °F. (16)	FLUE GAS TEMP. BOILER 2 °F. (17)	FLUE GAS TEMP. BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 BLR O/S (22)	CWM/ (23)
1	200		2030		2030	276	183	4880	80	3	223	19920		11			430		380	6	[illegible]	28	430
2	200		2033		2033	271	455	2360	81	3	223	17770		11			430		380	6	W	60	430
3	200		2003		2003	257	487	4880	84	3	223	18120		11			430		382	6	EH	64	4300
4	200		1970		1970	264	473	4880	82	3	223	19050		11			430		332	6	DR	62	415
5	200		2026		2026	272	400	43070	80	3	223	13,010		11			430		382	6	[illegible]	53	390
6	200		2011		2011	250	1115	39680	80	3	223	13510		11			430		381	6	W	147	420
7	200		2022		2022	260	734	21750	76	3	223	16090		11			430		381	6	[illegible]	97	420
8	200		2026		2026	274	354	4880	78	3	223	17210		11			430		380	6	W	47	400
9	200		2050		2050	263	634	24120	78	3	223	16420		11			430		380	6	[illegible]	79	410
10	200		1977		1977	267	305	57370	80	3	223	12430		11			430		380	6	[illegible]	40	4100
11	200		2031		2031	278	614	4880	78	3	223	17110		11			430		381	6	[illegible]	80	420
12	200		1996		1996	263	618	4880	80	3	223	14850		11			430		380	6	W	20	[illegible]
13	200		1992		1992	261	700	10	78	3	223	15590		11			430		380	6	[illegible]	94	3800
14	200		1951		1951	259	528	22510	82	3	223	15020		11			430		380	6	W	72	370
15	200		1970		1970	259	655	37660	82	3	223	18590		11			430		380	6	[illegible]	86	370
16	200		1991		1991	267	376	5930	76	3	223	17880		11			430		380	6	[illegible]	50	4200
17	200	2649	1912		1912	221	2649	7610	85	3	223	13990		11			430		380	6	[illegible]	306	4,00
18	200	2700	1945		1945	267	2700	4880	84	3	223	11160		11			430		382	6	74	285	4100
19	200	839	1842		1842	235	1165	6550	82	3	223	5240		11			430		380	6	W	35/103	6900
20	200		1986		1986	266	389	35060	81	3	223	9080		11			430		386	6	CCP	51	3900
21	200		1982		1982	258	326	26110	80	3	223	10430		11			430		381	6	W	103	4400
22	200	2715	2043		2043	263	2715	4880	83	3	220	9310		11			430		380	6	DT	333	400
23	200	2672	2038		2038	234	1381	4880	78	3	223	6640		11			430		380	6	"	328	400
24	200	1381	1960		1960	246	2672	20	78	3	223	11450		11			430		380	6	[illegible]	170	4100
25	200		2010		2010	272	266	7800	76	3	223	8500		11			430		380	6	74	35	410
26	200		2101		2101	265	1336	4880	80	3	223	5730		11			430		380	6	W	176	380
27	200		2050		2058	273	550	2150	80	[illegible]	[illegible]	9470		[illegible]								[illegible]	[illegible]
28	200		2123		2123	279	743	2820	80	3	223	11630		11			430		384	6	DT	98	400
29	200		2160		2100	272	351	1230	80	3	224	12460		11			430		381	6	W	176	390
30	200		2089		2089	279	750	770	80	3	224	8,540		11			430		381	6	[illegible]	69	630
31	200		2109		2109	288	154	4880	86	3	224	7310		11			430		384	6	[illegible]	21	3,200
TOTAL	6820	12956	62837		62837	8169	13822	874295	2488			40710							11796	186			
MAXIMUM	220	2715	2058		2058	288	2715	57370	86			19920							384	6			
MINIMUM	220	839	1842		1842	234	183	10	76			5240							380	6			
AVERAGE	220	2159	2014		2014	2653.5	531.6	28203	80			13132							380.5	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS: 404010

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-79

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313 | PLANT: | BLDG. NO.: | MONTH: Jul 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. (6) Wood	#2 FUEL USED LB. M.C.F. GAL. Oil (7)	NG EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	2 (14)	3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	2 °F. (17)	3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 Bn F.O.S.F. (22)	Chilled water makeup (23)
1	200	677		1000	1677		6000	614000	86	3	223	12920	11	·	11	420	'	420	380	13	JW		8200
2	200	758		1000	1758		6000	612600	86	3	223	15530	11		11	420		420	380	3	JW		8100
3	200	744		1000	1744		6000	616900	83.5	3	223	12,250	11		11	420		420	380	3	OP		8400
4	200	765		1000	1765		6,000	617000	80.5	3	223	12,760	11		11	420		420	380	3	OP		8400
5	200	828		1000	1828		6000	646,300	83	3	223	13,570	11		11	420		420	380	3	JW		8500
6	200	847		1000	1847		6000	657200	88	3	223	10,620	11		11	430		430	380	3	Fu		8300
7	200	851		1000	1851	Est	6000	641600	83	3	223	21,960	11		11	430		430	380	3	EJ		8200
8	200	861		1000	1861	Est	6000	665,000	87.5	3	223	14,500	11		11	430	4	430	380	3	OP		8,200
9	250	390	1182	392	1564	177	3048	276000	87	3	223	18320				430	430	430	380	3	JW		8500
10	200	250	1500	305	2095	200	2337	551,100	85	3	223	15,400				430	430	430	380	3	JW		9600
11	200		2058		2058	279	2220		88	3	223	17,130		11			430		380	3	OP	29	8600
12	200		1984		1984	264	2507		84	3	223	17,310		11			430		380	6	OP	67	7100
13	200		2103		2103	290	2260		87	3	223	25130		11			430		380	6	Dn	34	6400
14	200		2020		2020	278	419		87	3	223	21390		11			430		380	6	EH	55	7700
15	200		2097		2097	282	560		87	3	223	13,200		11			430		380	6	OP	49	7,8000
16	200		2036		2036	266	872		88	3	223	18480		11			430		380	6	W	107	7600
17	200		2029		2029	267	800		87	3	223	17,870		11			430		380	6	OP	92	7600
18	200		2057		2057	277	344		84	3	223	18070		11			430		380	6	W	45	8300
19	200		2044		2044	273	440		88	3	223	20,870		11			430		380	6	OP	59	8400
20	200		2067		2067	285	925		78	3	223	18490		11			430		380	6	Dn	122	8100
21	200		2101		2101	289	791	40	77	3	223	21440		11			430		380	6	Dn	104	6200
22	200		2027		2027	273	365		78	3	223	17360		11			430		380	6	W	48	4800
23	200		2012		2012	260	949	895	84	3	223	17800		11			430		380	6	W	125	4400
24	200		2039		2039	257	1193	3125	84	3	223	15080		11			430		380	6	CP	159	4000
25	200		1926		1926	266	837	0	85	3	223	20240		11			430		380	6	W	111	4300
26	200		2038		2038	268	713	2410	84	3	223	18840		11			430		380	6	Dn	44	4200
27	200		2035		2038	264	682	2940	83	3	223	17160		11			430		380	6	Dn	90	4000
28	200		1977		1977	273	1005	–	79	3	223	19530		*			430		380	6	ELB	133	4100
29	200		1912		1912	244	1062	–	79	3	223	16960		11			430		380	6	W	140	4000
30	200		1989		1989	255	1058	–	81	3	223	23,260		11			430		380	6	OP	140	4100
31	200		1998		1998	271	2213	31760	78	3	223	11,460		11			430		380	6	W	28	4300
TOTAL	6820	7051	45241	8697	60989	6052	75497	5572930	2601			535250								153			
MAXIMUM	220	861	2103	1000	2163	290	6000	665000	88			25130								6			
MINIMUM	220	290	1182	305	1677	171	344	40	77			10620								3			
AVERAGE	220	705	1967	870	1967	253	2435	371515	84			17266								5			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS: 540670

SEE REVERSE SIDE FOR INSTRUCTIONS | PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-80

A.5-80

A.5-81

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP | BLDG. NO. 1412 | MONTH: JUNE 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 4 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	Wood FEED WATER TO BOILER 1,000 LB. (6)	#2 FUEL USED LB. M.C.F. GAL. Oil (7)	NAT. GAS (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 4 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 4 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 BLR Oil S/F (22)	Chilled WTR MAKE-UP (23)
1	200	419	1336	190	1845	123	28	448100	83°	3	223	7548		6		420	420	420	385	6	DR	7	18900
2	200		1421	588	2009	122	60	383600	85°	3	223	13240							386	6	ELB		18400
3	200		1390	636	2026	122	52	432020	77	3	223	10790							383	6	W	7	20600
4	200	5.1	1366	857	2223	123	44	456390	81	3	223	10470							385	6	E7	6	18100
5	200	50		1777	1827	123	50	654220	80	3	223	8960							385	6	E7	0	10,800
6	200	900		948	1848	—	7100	652000	82	3	223	9080							382	3	W	—	11010
7	200	997		1000	1997	—	7400	565540	81	3	223	11300							383	3	E7	—	9490
8	200	875		891	1766	—	7350	655410	87	3	223	9000							382	3	FW	—	1800
9	200	741		1112	1853	—	7350	663660	86°	3	223	4580							382	3	ELB	—	6600
10	200	861		1000	1861	—	7400	652000	82	3	223	8600							382	#3-3	JV	—	3500
11	200	830		1000	1830	-0-	7400	640,000	81	3	223	9520							383	#3-3	EE	—	3400
12	2000	824		1000	1824	—	7375	650,000	80	3	223	11,130							382	#3-3	JV	—	3500
13	200	832		1000	1832	—	7375	650000	81	3	223	12,140							383	#3-3	E7	—	3500
14	200	829		1000	1829	—	7329	650,000	84	3	223	9190							383	#3-3	JV	—	2530
15	200	879		1000	1879	—	7400	650,000	86	3	223	12770							383	#3-3	FW	—	3800
16	200	901		1000	1901	—	7400	650,000	80	3	223	11090							383	#3-3	FW	—	1300
17	200	882		1000	1882	—	7375	650000	78	3	223	14452							382	#3-3	E7	—	4100
18	200	863		1000	1863	—	7375	650000	77	3	223	11850							383	#3-3	JV	—	4500
19	200	850		1000	1850	—	7400	650000	75	3	223	11,050							383	#3-3	JV	—	4400
20	200	894		1000	1894	— Est	7350	650000	84	3	223	14080							383	#3-3	[illegible]		4800
21	200	914		1000	1914	"	7375	650000	91	3	223	14310							382	#3-3	[illegible]		4700
22	200	865		1000	1865		7350	655100	91	3	223	13920							383	#3-3	EF		4300
23	200	884		1000	1884		7400	677,200	90	3	223	5720							384	#3-3	EF		4200
24	200	863		1000	1863		7325	627,999	85	3	223	15520							383	#3-3	[illegible]		4900
25	200	771		1000	1771		7400	614,600	80	3	223	14,020							383	#3-3	PMP	—	7300
26	200	764		1000	1764		7400	627,900	81	3	223	15,320							383	#3-3	PMP	—	8,000
27	200	846		1000	1846		7375	624,340	88	3	223	14,220							383	#3-3	PMP	—	7,600
28	200	745		1000	1745		7375	624,540	89	3	223	14,180							383	#3-3	PMP	—	7,800
29	200	770		1000	1770		7375	615,000	85	3	223	12,200							383	#3-3	FW	—	8,100
30	200	884		1000	1884	Est	7400	532,000	83	3	223	15,310							383	#3-3	E7	—	8300
31	200	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]														
TOTAL	6600	21733	5513	28999	56245	613	184388	18922740	2497			352488							11493	105			215330
MAXIMUM	200	997	1421	1112	2223	123	7404	677200	91			17420							386	6			
MINIMUM	200	50	1336	190	1745	122	44	383600	75			4580							382	3			
AVERAGE	200	834	1378	967	1875	122.6	6146	630758	83			11750							383	3.5			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS 352588

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

Jun 94

Natural Gas 18,922,740 Cu. ft.

Wood 613 Tons

Used Oil -0-

#2 Oil 184,388 gals

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5??, 1 JUN ??, WHICH WILL BE USED.

A.5-81

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: C2P | BLDG. NO.: 1412 | MONTH: MAY '94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1, 1,000 LB. (2)	BOILER 4, 1,000 LB. (3)	BOILER 3, 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD FEED-WATER TO BOILER 1,000 LB. (6)	NO. 2 FUEL USED LB. M.C.F. GAL. OIL (7)	NAT GAS (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)
1	200	267	1682		1942	232	0	202530	82.5	3	223	9870
2	200	356	834	600	1790	115	15	579140	78	3	223	14070
3	200	317	962	600	1879	129	208	597390	67	3	223	7580
4	200		1681		1681	225	356	6770	67	3	223	7980
5	200		1766		1766	174	144	2390	67	3	223	11910
6	200		1260		1260	173	169	4160	72	3	223	7940
7	200		1293		1293	176	165	10600	77	3	223	12030
8	200	290	1375		1665	189	165	241680	75	3	223	9730
9	200	691	1233		1924	170	—	536920	75	3	223	8760
10	200	579	1357		1936	187	254	418320	73	3	223	9730
11	200	758	1154		1912	156	176	548930	72	3	223	11,390
12	220	801	1175		1976	162	104	616220	78	3	223	8350
13	220	773	1246		2019	167	247	532770	73	3	223	5510
14	220	700	1223		1923	167	162	501600	74	3	223	11480
15	220	672	1277		1949	175	147	512000	72	3	223	8280
16	220	639	1273		1912	175	242	504110	83	3	223	5680
17	220	669	1292		1961	167	181	492180	76	3	223	10250
18	220	649	1285		1934	174	149	463150	71	3	223	7530
19	220	416	1369		1785	186	118	316890	59	3	223	9460
20	220	—	1602		1602	221	270	5900	60	3	223	11870
21	220	—	1663		1663	228	163	6320	60	3	223	12320
22	220	100	1021	273	1394	130	590	258290	67	3	223	11510
23	220	400	374	798	1572	47	226	737900	73	3	223	8470
24	220	640	1395		2035	192	154	403100	84	3	223	12550
25	220	649	1370		2019	189	0	505100	80	3	223	9700
26	220	594	1361		1955	186	73	456240	83	3	223	10950
27	220	591	1338		1929	184	126	484710	82	3	223	10170
28	220	629	1254		1883	173	0	469600	71	3	223	7960
29	220	628	1272		1900	175	87	506500	73	3	223	9910
30	220	714	1264		1978	173	57	468790	68	3	223	8850
31	220	660	1282		1942	177	165	460030	79	3	223	11950
TOTAL	6820	14182	39933	2271	56386	5374	4853	11816530	2271			305540
MAXIMUM	220	801	1766	798	2035	228	590	616220	84			14070
MINIMUM	220	100	374	273	1260	47	15	2390	59			5510
AVERAGE	220	567	1288	568	1819	173	180	381178	73			9856

DATE	%CO2 BOILER 1 (13)	%CO2 BOILER 4 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 4 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	NO. 4 BLR OIL S/F (22)	Chilled Water Make-up (23)
1		6			420		384		ELB		
2		6		420	420	420	385		Dn	2	
3		6		420	420	420	385		Dn	27	
4		6			420		385		FW	45	
5		7			450		387		W	5	
6		6			450		385		Dn	9	
7		6			450		386		ELB	14	
8		6		420	420		385		ELB	9	
9		6		420	420		385		Dn	0	
10		6		420	420		385		Dn	34	
11		6		420	420		385		FW	10	
12		6		420	421		383		W	13	
13		6		420	420		385		TH	33	
14		6		420	420		385		TH	8	
15		6		420	420		385		TH	6	
16	—	6		420	420		385		Dn	32	
17		6		420	420		383		W	11	25,300
18		6		420	420		385		Dn	20	17,800
19		6		420	420		382		W	16	16,300
20		6		—	420		382		DR	36	12000
21		6		—	420		383		ELB	8	13810
22		6		420	422	420	383		Dn	78	13600
23		6		420	420	420	383		Dn	30	15200
24		6		—	420	—	384		ELB	7	18500
25		6		420	420		384		TH	0	21,600
26		6		420	420		384		TC	9	23,200
27		6		420	420		384		ELB	3	17600
28		6		420	420		384		EF	0	14900
29		6		420	420		384		TH	11	20400
30		6		420	420		384		EH	7	19000
31		6		420	420		382		W	22	18200
TOTAL							11911	186			
MAXIMUM							386	6			
MINIMUM							382	6			
AVERAGE							384	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): Wood: 1934.64, OIL: 26.92, Nat. Gas: 487.31

REMARKS: 309740

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-82

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313 GAS
PLANT: CER
BLDG. NO.: 1412
MONTH: April 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 1 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WATER TO BOILER 1,000 LB. (6)	NO 2 FUEL USED LB. M.C.F. GAL. Oil (7)	(8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	% CO2 BOILER 4 (13)	% CO2 BOILER 2 (14)	(15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	No 4 Oil S/F (22)	(23)
1	220	1237			1237	170	-0-	-0-	56	3	223	22740	7			420			376	6	EZ	-0-	
2	220	1206			1206	166	0	0	60	3	223	27130	7			420			377	6	W	0	
3	220	1178			1178	162	0	0	65	3	223	22670	7			420			375	6	EZ	-0-	
4	220	1213			1213	167	11	0	66	3	223	22190	7			470			377	6	W	2	
5	220	1231			1231	170	-0-	-0-	69	3	223	23930	7			470			377	6	EZ	-0-	
6	220	1199			1199	165	27	-0-	75	3	223	24730	7			470			377	6	EZ	4	
7	220	1238			1238	120	24	600	63	3	223	24140	7			470			376	6	MW	3	
8	220	1224			1224	169	0	0	59	3	223	20050	7			470			377	6	W	0	
9	220	1121			1121	254	-0-	-0-	64	3	223	22500	7			470			376	6	EZ	-0-	
10	220	1138			1138	157	30	[illegible]	71	3	223	21360	7			460			378	6	W	4	
11	220	1397			1397	186	381	—	71	3	223	25640	7			460			377	6	EZ	50	
12	220	1807			1807	249	132	—	73	3	223	16220	7			460			378	6	W	17	
13	200	1771			1771	244	383	-0-	71	3	223	24130	7			460			376	6	EZ	51	
14	200	1508			1508	202	298	0	76	3	223	10810	7			460			375	6	[illegible]	39	
15	200	1281			1281	274	122	—	75	3	223	4740	7			460			375	6	[illegible]	16	
16	200	1311			1311	280	—	—	68	3	223	4500	7			460			378	6	EZ	—	
17	200	1340			1340	284	5	—	65	3	223	16250	7			460			376	6	[illegible]	0.65	
18	[illegible]	[illegible]			1340	284	5		70	3	223	10280	7			[illegible]			376	6	[illegible]	E5	
19	200	1330			1330	281	49		70			13500							[illegible]			15	
20	200	1713			1713	234	97		76	3	223	10890	7			460			375	[illegible]	[illegible]	13	
21	200	2034			2034	268	645		78	3	223	[illegible]	7			440			378	6	[illegible]	85	
22	200	2012			2012	277	152		75	3	223	3840	7			460			376	6		20	
23	200	1399			1399	269	55		61	3	223	4600	7			460			377	6		7	
24	200	1433			1433	196	92		67	3	223	10260	7			460			378	6		12	
25	200	1837			1837	242	586		74	3	223	9830	7			460			379	6	[illegible]	77	
26	200	2019			2019	278	191		75	3	223	10130	7			460			378	6	On	25	
27	200	1932			1932	262	219	689910	74	3	223	10010	7			480			379	6	W	29	
28	200	1540	170	250	1960	296	890	366800	74	3	223	7180	7			460		420	378	6	On	[illegible]	
29	200	1170	769		1939	261	01	191400	71	3	223	13110	7			460			378	6	On	0	
30	200	1130	880		2010	256	18	551500	75	3	223	14520	7			460			379	6	On		
31																							
TOTAL	6600	42289	1819	250	44358	6871	4412	1710010	2087			453410							11316	180			
MAXIMUM	220	2034	880	250	2034	296	890	604310	78			27130							379	6			
MINIMUM	220	1130	170	250	1121	157	5	191900	56			3840							375	6			
AVERAGE	220	1410	606	250	1479	229	192	428503	69.6			15114							377	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-83

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP | BLDG. NO.: 1412 | MONTH: MAR 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD 1,000 LB. (6)	No. 2 FUEL USED GAL. OIL (7)	WASTE OIL (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 4 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	No. 4 BLR OIL S.F. (22)	(23)
1	220	1587			1587	217	87		58	3	223	25100	7			450			375	6	W	11	
2	220	1463			1463	195	346		60	3	223	20320	7			410			325	6	BN	45	
3	220	1710			1710	217	978		52	3	223	23750	7			450			325	6	BN	129	
4	220	1555			1555	206	402		61	3	223	22910	7			450			375	6	WR	53	
5	220	1422			1422	188	427		63	3	223	17320	7			450			374	6	W	56	
6	220	1400			1400	187	307		63°	3	223	25590	7			450			375	6	Bn	40	
7	220	1387			1387	188	149		67	3	223	21860	7			450			378	6	W	20	
8	220	1415			1415	192	140		68°	3	223	22170	7			450			377	6	Bn	18	
9	220	1387			1387	191	186		68°	3	223	20290	7			450			378	6	Bn	26	
10	220	1372			1372	186	160		66°	3	223	26490	7			450			376	6	Bn	21	
11	220	1670			1670	227	146		45	3	223	28540	7			450			373	6	W	19	
12	220	1596			1596	211	496		51	3	223	23920	7			450			373	6	Bn	63	
13	220	1525			1525	204	338		52	3	223	23450	7			450			376	6	W	45	
14	220	1463			1463	199	122		58	3	223	27960	7			458			375	6	Bn	16	
15	220	1331			1331	182	67		58	3	223	25260	7			450			378	6	W	9	
16	220	1408			1408	194	97		63	3	223	26090	7			450			376	6	Bn	13	
17	220	1501			1501	206	37		54	3	223	26040	7			450			377	6	Bn	5	
18	220	1422			1422	193	19		64°	3	223	23560	7			450			376	6	Bn	3	
19	220	1433			1433	195	151		64	3	223	24340	7			420			373	6	[illegible]	19	
20	220	1326			1326	183	-0-		67	3	223	29390	7			420			374	6	EJ	0	
21	220	1292			1292	178	27		71	3	223	28510	7			420			376	6	W	4	
22	220	1307			1307	180	-0-		67	3	223	26570	7			420			373	6	EJ	-0-	
23	220	1280			1280	176	-0-		65	3	223	28150	7			420			375	6	MW	-0-	
24	220	1261			1261	174	-0-		73	3	223	27000	7			420			374	6	EJ	-0-	
25	220	1240			1240	179	0		70	3	223	31750	7			420			375	6	MJ	0	
26	220	1260			1260	173	3		63	3	223	24160	7			420			375	6	EJ	-0-	
27	220	1257			1257	173	88		68	3	223	27560	7			420			378	6	W	12	
28	220	1190			1190	164	-0-		72	3	223	31250	7			420			376	6	EE	-0-	
29	220	1329			1329	183	85		62	3	223	31690	7			420			373	6	W	11	
30	220	1306			1306	180	48		56	3	223	28445	7			420			375	6	EJ	6	
31	220	1306			1306	180	0		57	3	223	23000	7			420			377	6	W	0	
TOTAL	6820	43390			43390	5894	5736		1926	93.0	6820	793885	229.4			13082			11646	186			
MAXIMUM	220	1710			1710	227	978		73	3.0	220	31750	7.4			422			378	6			
MINIMUM	220	1240			1240	164	3		45	3.0	220	17320	7.4			422			373	6			
AVERAGE	220	1400			1400	190	239		62	3.0	220	25610	7.4			422			376	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS: 8

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-84

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CEP

BLDG. NO. 1412

MONTH: Feb 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER #4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD 1,000 LB. (6)	No. 2 OIL FUEL USED GAL. (7)	Waste OIL (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	BOILER 2 (14)	BOILER #4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER #4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	#4 BLR S/F For oil used (22)	(23)
1	200			1931	1931	254	638	—	43			14200			7.4			420	373	6	W	84	
2	200			2089	2089	217	1108	—	38			17160			7			420	375	6	Dn	146	
3	200			2027	2027	274	258	—	40			17440			7			420	325	6	JL	34	
4	200			2012	2012	259	1025	—	43			15090			7			420	375	6	Dn	135	
5	200			1851	1851	239	831	—	45			15960			7			420	373	6	W	110	
6	200			1778	1778	229	740	—	55			20770			7			420	375	6	Dn	95	
7	200			1687	1687	228	239		59			15340			7			420	377	6	W	31	
8	200			1594	1594	210	528		63			17870			7			420	375	6	Dn	70	
9	200			1515	1515	199	489	w/o	69			19420			7			420	375	6	JL	65	
10	200			1516	1516	206	156		65			18420			7			420	374	6	JL	20	
11	200			1501	1501	203	189		66			20090			7			420	376	6	W	25	
12	200			1505	1505	203	200		52			19010			7			420	375	6	Dn	26	
13	200			1652	1652	222	291		55			18160			7			420	373	6	W	38	
14	200			1810	1810	238	582		52			21660			7			420	374	6	Dn	76	
15	200			1792	1792	240	409		56			20380			7			420	375	6	W	119	
16	200			1757	1757	238	171		52			23820			7			420	375	6	Dn	22	
17	200			1623	1623	220	209		55			20440			7			420	324	6	JL	28	
18	200			1598	1598	215	294		57			16770			7			420	375	6	Dn	39	
19	200			1466	1466	195	367		61			20080			7			420	377	6	W	48	
20	200			1511	1511	202	356		60			25150			7			420	376	6	Dn	45	
21	200			1481	1481	204	13		65			21440			7			420	378	6	W	2	
22	200			1389	1389	190	53		65			21490			7			420	377	6	Dn	7	
23	200			1395	1395	190	73		66			26080			7			420	376	6	JL	10	
24	200			1446	1446	184	25	850	60			22740			7			420	328	6	JL	211	
25	200			1540	1540	168	—	2509	50			21170			7			420	375	6	W	320	
26	200			1556	1556	169		2462	55			21720			7			420	375	6	RS	202	
27	200			1811	1811	241	472	—	44			19240			7			420	373	6	W	62	
28	200			1641	1641	216	564	—	48			20120			7			420	375	6	Dn	74	
29																							
30						N.G.	(2548)																
31																							
TOTAL	6160			46474	46474	5846	13678	5861	1539			551230			207.2			11816		168			
MAXIMUM	220			2089	2089	274			69			26080			7.4			422		6			
MINIMUM	220			1389	1389	103			38			14200			7.4			422		6			
AVERAGE	220			1660	1660	209			55			19687			7.4			422		6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS) 19539

2509

13

698

REMARKS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 3967, 1 NOV 72 REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

A.5-85

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART FORT STEWART, GEORGIA 31313

PLANT: C.E.P. | BLDG. NO.: 1417 | MONTH: JAN 94

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	STEAM PRODUCED BOILER 2 1,000 LB. (3)	STEAM PRODUCED BOILER 4 1,000 LB. (4)	STEAM PRODUCED TOTAL 1,000 LB. (5)	WHB BOILER 1,000 LB. (6)	FUEL USED MCF NG (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. WQ (10)	FEEDWATER HEATER TEMP. °F. (11)	FEEDWATER HEATER MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 3 (14)	%CO2 BOILER 4 (15)	FLUE GAS TEMP. BOILER 1 °F. (16)	FLUE GAS TEMP. BOILER 3 °F. (17)	FLUE GAS TEMP. BOILER 4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES #4 (20)	PREVENT MAINT. CHECK OPR (21)	No 4 BLR No 2 FO (22)	S.F.Oil #4 BLR waste w (23)
1	200			1726	1726	156	-0-		48	-0-		19610			7			420	373	6	EJ	4500	593
2	200	497		1072	1569	57			53	—		22970			7			420	374	6	EJ	4882	674
3	200	700	895		1595	-0-			51	—		27360	7	7		420	420		376	6	EJ	5800	—
4	200	900	968		1868	—	—		46	—		14630	7	7		420	420		378	3	EB	5660	—
5	200	1600	734	400	1774	55	—		40	—		15970	—	—	7	—	—	420	377	1	EB	1506	—
6	200			1850	1850	252			47			18580			7			420	326	6	EF	1128	17
7	200			1590	1590	219	—		56	—		24220			7			420	375	6	JW	1408	53
8	200			1608	1608	214			50	—		25780			7			420	372	6	W	1421	36
9	200			2019	2019	268	—		37	—		26590			7			420	374	6	EJ	1584	72
10	200			2040	2090	278			39	—		26270			7			420	372	6	W	1187	39
11	200			1856	1856	242			50			27840			7			420	375	6	EJ	1781	96
12	200			1690	1690	205			56	—		22680			7			420	376	6	EB	2513	200
13	200			1707	1707	213			49			22050			7			420	374	6	EJ	2214	160
14	200			1808	1808	242			48			15020			7			020	373	6	W	1389	51
15	200			1923	1923	261	31,190		36			21080			7			420	374	6	EJ	1252	31
16	200			2135	2135	288		20	27			22930			7			420	372	6	W	1352	27
17	200			1912	1912	255			48			17550			7			420	373	6	EJ	1440	61
18	200			1974	1974	265			38			20730			7			420	372	6	W	1322	50
19	200			2227	2227	305			30			23850			7			420	374	6	EJ	2590	209
20	200			2223	2223	295			33			22130			7			420	375	6	EB	1618	82
21	200			2085	2085	281			35			18870			7			425	372	6	EJ	1946	43
22	200			2038	2038	281			39			18690			7			425	372	6	W	1113	15
23	200			1990	1990	268			45			16020			7			425	372	6	Dn	1356	47
24	200			1800	1800	248			49			19140			7			425	375	6	W	1239	32
25	200			1678	1678	221			54			17180			7			425	375	6	Dn	1538	71
26	200			1561	1561	215			62			14130			7			420	378	6	W	1179	24
27	200			1579	1579	197			53			17120			7			425	375	6	Dn	2401	145
28	200			1520	1520	209			64			16330			7			425	377	6	W	2566	75
29	200			1547	1547	178			57			17580			7			425	375	6	Dn	2910	251
30	200			1721	1721	216			44			14480			7			425	378	6	W	2118	147
31	200			1867	1867	244			45			17570 70			7			425	377	6	Dn	1696	92
TOTAL	6820	2197	2597	51156	55950	6628	31190		1434			626120							11610	186		66349	
MAXIMUM	220	900	968	2227	2227	305	31190		64			27840							378	6		5800	
MINIMUM	220	497	734	400	1520	55	31190		27			14630							372	6		1113	
AVERAGE	220	549	866	1764	1805	228.6	31190		46			20197							375	6		2140	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 1 NOV 72 3967 REPLACES DA FORM 6-98, 1 JUN 58, WHICH WILL BE USED.

A.5-86

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: DECEMBER 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	STEAM PRODUCED BOILER 2 1,000 LB. (3)	STEAM PRODUCED BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD 2,000 LB. (6)	NAT. GAS FUEL USED C.F. (7)	OIL LB. PER UNIT * (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS TEMPERATURE BOILER 2 °F. (17)	FLUE GAS TEMPERATURE BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220	794	1000		1794		1237960	1290	49	3.0	220	15770	[illegible]	7.4		422	422		373	6	[illegible]		
2	220	774	1000		1774		1190770	960	51	3.2	223	9850	7.4	7.4		422	422		374	6	[illegible]		
3	220	737	1000		1737		1179640	840	56	3.0	220	15310	7.4	7.4		422	422		[illegible]	6	[illegible]		
4	220	734	900		1634		1081500	1110	66	3.0	220	14900	7.4	7.4		422	422		[illegible]	6	FW		
5	220	773	900		1673		1106370	1210	61	3.0	220	13840	7.4	7.4		422	422		373	6	FW		
6	220	751	900		1691		1119330	990	60	3.0	220	12440	[illegible]	7.4		422	422		[illegible]	6	[illegible]		
7	220	672	800	352	1824	48	983500	1260	50	3.0	220	12290	[illegible]	7.4	7.6	422	422	420	373	6	FW		
8	220			1769	1769	232	10120	1410	50	3.0	220	11900			7.4			422	373	6	FW		
9	220			1616	1616	223	46300	2030	51	3.1	221	10640			7.4			422	[illegible]	6	ELB		
10	220			1589	1589	207	7380	1786	54	3.0	220	15020			7.4			422	375	6	FW		
11	220			1866	1866	221	12850	2075	48	3.0	220	12230			7.4			422	370	6	EF		
12	220			1701	1701	204	15050	1783	39	3.0	220	17440			7.4			422	373	6	ELB		
13	220			1669	1669	190	7720	2328	39	3.0	220	18190			7.4			422	373	6	EF		
14	220			1602	1602	174	10980	2741	51	3.0	220	17800			7.4			422	374	6	ELB		
15	220			1416	1416	194	9560		46	3.0	220	24350			7.4			422	375	6	ELB		
16	220			1572	1572	137		474	49	3.0	220	13560			7.4			422	374	6	ELB		
17	220			1571	1571	174		2513	49	3.0	220	14870			7.4			422	375	6	EF		
18	220			1497	1497	178		1665	54	3.0	220	14830			7.4			422	373	6	[illegible]		
19	220			1595	1595	196		1429	47	3.0	220	16290			7.4			422	374	6	EF		
20	220			1729	1729	226		730	48	3.0	220	17460			7.4			422	374	6	EF		
21	220			1622	1622	223			48	3.0	220	18540			7.4			422	373	6	EF		
22	220			1856	1856	245		621	40	3.0	220	16060			7.4			422	374	6	EF		
23	220			1933	1923	199		1728	40	3.0	220	17860			7.4			422	373	6	[illegible]		
24	220			1916	1916	234		1781	36	3.0	220	14990			7.4			422	374	6	EF		
25	220			1913	1930	237		1690	42	3.0	220	17650			7.4			422	372	6	[illegible]		
26	220			1875	1875	225		1991	39	3.0	220	22880			7.4			422	373	6	EF		
27	220			1810	1813	148		998	49	3.0	220	21180			7.4			422	374	6	[illegible]		
28	220			1664	1664	127		840	53	3.0	220	27800			7.4			422	374	6	[illegible]		
29	220			1594	1598	313		1018	56	3.0	220	26840			7.4			422	375	6	ELB		
30	[illegible]			[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]			[illegible]					
31	220			1833	1833	[illegible]		[illegible]	37	3.0	220	20550			7.4			422	372	6	[illegible]		
TOTAL	6820	5235	6500	41312	53047	4808	8219030	44212	1496	93.3	6824	[illegible]	51.8	51.8	185.2	2954	2954	10548	11578	186			
MAXIMUM	220	794	1000	1875	1875	[illegible]	1237960	2741	66	3.2	223	27800	[illegible]	[illegible]	7.6	422	422	422	375	6			
MINIMUM	220	672	800	352	1497	48	[illegible]	474	36	3.0	220	9850	7.4	7.4	7.4	422	422	420	370	6			
AVERAGE	220	748	929	1652	1711	192	524602	1426	48	3.0	220	17135	7.4	7.4	7.4	422	422	422	373	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1730.88, OIL: 245.29, NAT. GAS: 330.7

REMARKS: * RECLAIMED OIL F.S. 29572, NO. 2 OIL 14640

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE 11 Jan 94 | APPROVED BY [illegible signature] | DATE 11 Jan 94 | POST ENGINEER | DATE

DA FORM

A.5-87

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO.: 1412 | MONTH: NOVEMBER 1973

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS (6)	NAT. GAS FUEL USED C.F. (7)	NO.2 OIL (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER 4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220	600	752		1352		60	11350	43	3.0	220	19980	7.4	7.4		422	422		375	3	DR		
2	220	700	851		1551		1300	11350	46	3.0	220	23710	7.4	7.4		422	422		377	3	WB		
3	220	700	809		1509		4570	11350	58	3.0	220	23970	7.4	7.4		422	422		374	3	[illegible]		
4	220	700	820		1520		20	11350	66	3.0	220	23280	7.4	7.4		422	422		372	3	ARH		
5	220	700	802		1502		4790	11350	67	3.0	220	19300	7.4	7.4		422	422		373	3	FW		
6	220	700	798		1498		2070	11350	63	3.2	222	9580	7.4	7.4		422	422		374	3	WB		
7	220	700	884		1584		3190	11350	47	3.0	222	15810	7.4	7.4		422	422		372	3	[illegible]		
8	220	800	889		1689		3230	11350	47	3.0	222	20750	7.4	7.4		422	422		373	3	FW		
9	220	800	925		1725		32440	11350	46	3.0	222	18250	7.4	7.4		422	422		372	3	WB		
10	220	800	816		1616		3120	11350	48	3.1	222	10340	7.4	7.4		422	422		373	3	HR		
11	220	800	833		1633		4680	11350	48	3.0	220	24770	7.4	7.4		422	422		374	3	ARH		
12	220	800	838		1638		1480	11350	54	3.0	220	14190	7.4	7.4		422	422		374	3	FU		
13	220	700	842		1542		2430	11350	67	3.0	220	17460	7.4	7.4		422	422		374	3	FU		
14	220	700	770		1470		5350	11350	74	3.0	220	24400	7.4	7.4		422	422		374	3	FU		
15	220	700	787		1487		2850	11350	75	3.0	220	20310	7.4	7.4		422	422		374	3	FK		
16	220	700	772		1472		4030	11350	73	3.0	220	16900	7.4	7.4		422	422		374	3	FU		
17	220	700	729		1429		3420	11350	73	3.0	220	14650	7.4	7.0		422	422		373	3	ARH		
18	220		1031	440	1471	50	1700	11350	70	3.0	220	12120		7.4	7.6		422	420	374	3	ARH		
19	220		501	838	1339	150	387260	162	69	3.2	222	9870		7.5	7.5		421	421	373	3	FW		
20	220	700	828		1528		1081190		56	3.0	220	13190	7.4	7.4		422	422		374	3	FW		
21	220	800	893		1693		1205800		50	3.0	220	11260	7.4	7.4		422	422		373	3	FU		
22	220	800	951		1751		1156160		56	3.1	221	10090	7.4	7.4		422	422		373	3	FU		
23	220	800	888		1688		1108170		58	3.0	221	11110	7.4	7.4		422	422		373	3	FW		
24	220	800	819		1619		1013580		60	3.0	220	14170	7.4	7.4		422	422		372	3	ARH		
25	220	800	862		[illegible]		1114400		61	3.0	220	12560	7.4	7.4		422	422		374	3	ARH		
26	220	800	876		[illegible]		1126280		58	3.0	220	15940	7.4	7.4		422	422		373	3	FW		
27	220	800	826		1626		1110000		63	3.0	220	12950	7.4	7.4		422	422		374	3	FU		
28	220	800	892		1692		1133920		50	3.0	220	12990	7.4	7.4		422	422		373	3	FW		
29	220	800	989		1789		1228540		46	3.0	220	12610	7.4	7.4		422	422		372	3	FW		
30	220	800	991		1791		1214330		50	3.0	220	11060	7.4	7.4		422	422		372	3	FU		
31												570											
TOTAL	6600	21000	25264	1278	47542	200	12960310	204062	1742	90.6	6614	477660	207.2	223	15.1	11816	12659	841	11202	[illegible]			
MAXIMUM	220	800	1031	838	1791	150	1228540	11350	75	3.2	222	23970	7.4	7.5	7.6	422	422	421	375	3			
MINIMUM	220	600	501	440	1339	50	20	162	43	3.0	220	9580	7.4	7.4	7.5	422	421	420	372	3			
AVERAGE	220	750	842	639	1585	100	432010	16761	50	3.02	220.5	15922	7.4	7.4	7.55	422	422	420.5	373	3			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 72, NO.2 OIL: 1134.36, N.G: 534.47

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: [illegible] | DATE: 20 Dec 93 | APPROVED BY: Randy A. Parks | DATE: 20 Dec 93 | POST ENGINEER | DATE

DA FORM 2067

A.5-88

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: OCTOBER 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	STEAM PRODUCED BOILER 2 1,000 LB. (3)	STEAM PRODUCED BOILER 4 1,000 LB. (4)	STEAM PRODUCED TOTAL 1,000 LB. (5)	WOOD TONS 2,000 LB. (6)	OIL FUEL USED * GAL. (7)	NAT. GAS EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	FEEDWATER HEATER MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS TEMPERATURE BOILER 2 °F. (17)	FLUE GAS TEMPERATURE BOILER 4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220			711	711	147		2700	62	3.0	220	12050			7.6			420	383	6	[illegible]		
2	220			1174	1174	112		5660	67	3.2	222	7700			7.5			[illegible]	[illegible]	[illegible]	[illegible]		
3	220			1227	1227	167		3630	73	3.0	222	13030			7.4			422	383	6	DK		
4	220			1451	1451	151	1738	13210	78	3.2	223	9870			7.4			422	384	6	ELB		
5	220			1637	1637	152	4530	8491	75	3.1	222	10180			7.4			422	380	6	WB		
6	220			1324	1324	169	624	54360	69	3.0	220	17930			7.4			422	381	6	WB		
7	220			1686	1686	125	2365	5010	65	3.0	220	11340			7.4			422	380	6	WS		
8	220			1639	1639	118	3357	3570	71	3.1	222	9940			7.4			422	380	6	DK		
9	220			1582	1582	153	445	70	73	3.0	220	12920			7.4			422	381	6	ELB		
10	220			1640	1640	185		160	80	3.0	220	12930			7.4			422	380	6	ELB		
11	220	600	794		1394		9512	50	61	3.0	220	11560	7.5	7.4		421	422		380	3	ELB		
12	220	672	600		1272		9512	9920	62	3.0	220	13700	7.4	7.5		422	421		380	3	RP		
13	220	652	600		1252		9512		60	3.0	220	11490	7.4	7.5		422	421		380	3	EF		
14	220	627	600		1227		9512		65	3.2	222	9810	7.4	7.5		422	421		380	3	EF		
15	220	600	671		1271		9500	50	68	3.0	220	11030	7.5	7.4		421	422		382	3	ELB		
16	220	684	600		1284		9524		67	3.1	221	10470	7.4	7.5		422	421		381	3	GR		
17	220	625	625		1250		9524		69	3.0	220	13630	7.4	7.4		422	422		379	3	ELB		
18	220	650	735		1385		9500	4430	74	3.0	220	12970	7.4	7.4		422	422		380	3	DK		
19	220	650	748		1398		9512	40	74	3.0	226	16120	7.4	7.4		422	422		380	3	ELB		
20	220	600	788		1388		9512	3390	76	3.0	220	16440	7.5	7.4		421	422		380	3	EF		
21	220	700	787		1487		9512	2530	74	3.0	220	16250	7.4	7.4		422	422		380	3	EF		
22	220	650	726		1376		9500	10	69	3.1	221	9730	7.4	7.4		422	422		380	3	RP		
23	220	600	720		1320		9524	100	55	3.0	220	12290	[illegible]	[illegible]		421	422		[illegible]	3	ELB		
24	220	650	720		1370		9524		56	3.0	220	11200	[illegible]	[illegible]		1122	[illegible]		379	3	WS		
25	220	619	750		1369		9500	20	65	3.3	224	7500	7.4	7.4		422	422		379	3	[illegible]		
26	220	613	750		1363		9512	10	62	3.0	220	13800	7.4	7.4		422	422		378	[illegible]	[illegible]		
27	220	627	750		1377		9512		65	3.0	220	13280	7.4	7.4		422	422		378	3	WB		
28	220	600	602		1202		9512		60	3.0	220	13230	7.5	7.5		421	421		378	[illegible]	[illegible]		
29	220	500	699		1199		9500		55	3.0	220	13790	7.5	7.4		421	422		377	3	EF		
30	220	500	642		1142		9524	50	66	3.0	220	14070	7.5	7.4		421	422		379	[illegible]	ALH		
31	220	612	600		1212		9512	10	48	3.0	220	19420	7.5	7.4		421	422		377	3	[illegible]		
TOTAL	6820	13031	14407	14??	41509	1527	212802	117470	2065	94.3	6838	385750	156.2	155.8	74.3	8854	8859	4217	11781	123			
MAXIMUM	220	700	794	1686	1686	169	9524	54360	80	3.3	224	19420	7.5	7.5	7.6	422	422	422	384	6			
MINIMUM	220	500	600	711	711	112	445	10	56	3.0	220	7500	7.4	7.4	7.4	421	421	420	377	3			
AVERAGE	220	621	686	1467	1339	153	7600	5107	67	3.04	220.6	12444	7.44	7.42	7.43	421.6	421.8	421.7	380	3.97			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 550,44, OIL: 1180,63, NAT. GAS: 4.85

REMARKS: 391750
*=Reclaimed oil F.S.: 13051 GL, NO.2 [illegible] 174751 GL

PREPARED BY: [illegible signature] | DATE: 3 Nov 93 | APPROVED BY: | DATE: | POST ENGINEER: | DATE:

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 2067

A.5-89

A.5-90

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: SEPTEMBER, 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS 2,000 LB. (6)	OIL FUEL USED GAL. * (7)	NAT. GAS (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS TEMP. BOILER 2 °F. (17)	FLUE GAS TEMP. BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220			1795	1795	343	2266	15350	84	3.0	220	13990			7.4			422	384	6	MW		
2	220			1864	1864	350	2348	2860	84	3.0	220	11990			7.4			422	383	6	WB		
3	220			1557	1557	198	2152	12430	86	3.0	220	12520			7.4			422	384	6	[illegible]		
4	220			1800	1800	346	6023	14240	85	3.1	221	10900			7.4			422	383	6	PL		
5	220			1737	1737	263	4498	8060	82	3.0	220	12610			7.4			422	384	6	AXH		
6	220			1828	1828	296	3276	10840	82	3.0	220	15450			7.4			422	384	6	PL		
7	220	12		1839	1851	327	2138	28370	74	3.0	220	12290	7.6		7.4	420		422	382	6	AXH		
8	220			1929	1929	344	1850	5530	78	3.2	222	9010			7.4			422	382	6	MW		
9	220			1918	1918	356	1875	8580	79	3.0	220	12550			7.4			422	384	6	MN		
10	220		115	1719	1834	328	2550	14420	84	3.1	221	10250		7.6	7.4		420	422	384	6	PL		
11	220			1772	1772	332	2050	110	75	3.0	220	13230			7.4			422	383	6	AXH		
12	220			1752	1752	241	1800	288	76	3.0	220	12150			7.4			422	382	6	PL		
13	220		971	686	1657	192	2220	350	77	3.0	220	14510		7.4	7.6		422	420	384	6	AXH		
14	220	900	807		1707		2500	390	80	3.0	220	13360	7.4	7.4		422	422		382	6	FN		
15	220	900	723		1623		1000	110	82	3.0	220	13840	7.4	7.5		422	421		383	6	ET		
16	220	800	896		1696		1800	307520	87	3.0	220	12930	7.4	7.4		422	422		384	6	ET		
17	220	800	912	-	1712		2100	1257760	81	3.2	223	8570	7.4	7.4		422	422		383		AXH		
18	220	700	742		1442		1200	705823	82	3.0	220	12550	7.5	7.5		421	421		384		ELB		
19	220	800	813		1613		1300	1159000	81	3.1	222	10440	7.4	7.4		422	422		383		DR		
20	220	800	983		1783		1600	1367810	79	3.4	225	6310	7.4	7.4		422	422		383		ELB		
21	220	800	965		1765		1800	1260830	79	3.0	220	11060	7.4	7.4		422	422		384		LR		
22	220	800	907		1707		1850	1182490	77	3.1	221	10510	7.4	7.4		422	422		383		AXH		
23	220	800	871		1671		1800	1189030	75	3.2	222	9220	7.4	7.4		422	422		383		WB		
24	220	800	861		1661		1200	1180540	84	3.2	223	8430	7.4	7.4		422	422		383		ELB		
25	220	800	916		1716		1600	1220080	82	3.0	220	17800	7.4	7.4		422	422		384		LR		
26	220	800	829		1629		1400	1219910	86	3.0	220	15760	7.4	7.4		422	422		384		ELB		
27	220	800	873		1673		1400	1187930	81	3.1	221	10750	7.4	7.4		422	422		384		DR		
28	220	600	603		1203		1400	857750	67	3.1	221	10540	7.5	7.5		421	421		383		ELB		
29	220	500	601		1101		1500	875460	66	3.0	221	17160	7.5	7.5		421	421		382		WB		
30	220		507	627	1134	179	1560	327860	62	3.2	223	8140		7.5	7.5		421	421	781		LB		
31																							
TOTAL	6600	13212	15890		51925	3995	62065	15997620	2376	92.0	6626	359006 →358820	126.3	141.3	103.9	7169	8011	5905	11496	96			
MAXIMUM	220	900	983		1929	363	6032	1260830	87	3.4	225	17160	7.6	7.6	7.6	422	422	422	384	6			
MINIMUM	220	12	115		1101	179	1000	110	62	3.0	220	6310	7.4	7.4	7.4	420	420	420	381	6			
AVERAGE	220	734	795		1731	285	2059	533236	79	3.07	220.8	11967	7.43	7.44	7.42	421.7	421.6	421.8	383	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1438.2, OIL: 344.34, NAT. GAS: 659.72

REMARKS: * = Reclaimed oil F.S.: 16745, NO. 2 OIL: 45320

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: [signature] DATE: 10 Oct 93

APPROVED BY: [signature] DATE: 12 Oct 93

POST ENGINEER: DATE:

DA FORM

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: AUGUST 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS 2,000 LB. (6)	OIL FUEL USED GAL. * (7)	NAT GAS CU. FT. (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS BOILER 2 °F. (17)	FLUE GAS BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220		663	1147	1810	105	400	422890	88	3.1	221	10560		7.5	7.5		421	421	383	6	HEB		
2	220		674	1228	1899	105	400	487400	92	3.0	220	12220		7.5	7.4		421	422	384	6	HEB		
3	220		672	1215	1887	105	400	487780	90	3.1	221	10070		7.5	7.4		421	422	383	6	HEB		
4	220		677	1191	1868	105	400	531020	88	3.1	221	10050		7.5	7.4		421	422	383	6	FW		
5	220		612	1208	1820	105	400	480540	82	3.2	223	8970		7.5	7.4		421	422	382	6	JU		
6	220		549	1314	1863	105	1074	429280	86	3.1	221	10750		7.5	7.4		421	422	384	6	HEB		
7	220		435	1377	1812	105	3731	344266	83	3.1	221	10480		7.5	7.4		421	422	383	6	QLH		
8	220		361	1485	1846	105	3716	290500	83	3.0	220	15120		7.5	7.4		421	422	383	6	WS		
9	220		472	1377	1849	105	2665	362820	79	3.0	220	13750		7.5	7.4		421	422	384	6	QLH		
10	220		704	1171	1875	105	1200	514970	80	3.0	220	12340		7.4	7.4		422	422	384	6	WS		
11	220		658	1194	1852	105	200	514430	80	3.0	220	12470		7.5	7.4		421	422	384	6	MW		
12	220		545	1267	1812	105	200	486120	82	3.0	220	11780		7.5	7.4		421	422	383	6	EJ		
13	220		637	1156	1793	105	200	494900	88	3.0	220	11900		7.5	7.4		421	422	384	6	QLH		
14	220			1816	1816	105	200	2620	83	3.1	221	10400			7.4			422	385	6	WS		
15	220			1819	1819	105	200	11000	82	3.0	220	11780			7.4			422	385	6	HEB		
16	220			1831	1831	101	200	28860	80	3.1	220	10050			7.4			422	385	6	HEB		
17	220		172	1622	1794	100	200	159330	86	3.0	220	12320		7.6	7.4		420	422	385	6	HEB		
18	220			1732	1732	100	200	18260	86	3.0	220	11710			7.4			422	385	6	MW		
19	220	109		1631	1740	100	200	119630	83	3.0	220	16480	7.6		7.4	420		422	385	6	EJ		
20	220	20		1707	1727	100	200	50600	83	3.0	220	11350	7.6		7.4	420		422	384	6	QLH		
21	220			1772	1772	100	200	7820	91	3.1	221	10950			7.4			422	382	6	WS		
22	220			1788	1788	100	200	21590	86	3.0	220	14100			7.4			422	384	6	QR		
23	220			1796	1796	100	200	19710	83	3.0	220	12340			7.4			422	382	6	FW		
24	220			1827	1827	100	200	17660	79	3.0	220	15240			7.4			422	384	6	QLH		
25	220			1819	1819	100	246	14540	82	3.0	220	16510			7.4			422	385	6	BR		
26	220			1751	1752	100	288	27830	79	3.0	220	18270			7.4			422	385	6	MW		
27	220			1805	1805	100	129	24780	83	3.0	220	17960			7.4			422	383	6	WS		
28	220			1820	1820	100	206	8160	77	3.0	220	21740			7.4			422	382	6	QLH		
29	220			1823	1823	100	912	7440	82	3.0	220	21140			7.4			422	383	6	PL		
30	220	150		1611	1761	100	79	110370	79	3.0	220	26530	7.6		7.4			422	382	6	QLH		
31	220			1819	1819	100	82	7140	82			23240			7.4			422	382	6	PL		
TOTAL	6820	279	7831	48120	56230	3176	19130	6454210	2583	94.0	6830	432570	22.8	105.0	229.5	840	5894	13081	11891	186			
MAXIMUM	220	150	704	1831	1899	105	3716	531020	92	3.2	223	26530	7.6	7.6	7.5	420	422	422	382	6			
MINIMUM	220	20	172	1147	1727	100	42	2620	77	3.0	220	8970	7.6	7.4	7.4	420	420	421	385	6			
AVERAGE	220	93	559	1552	1814	102.5	617	208200	83	3.03	220.3	13954	7.6	7.5	7.4	420	421	422	384	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1143.36, OIL: 106.13, NAT GAS: 266.16

REMARKS: * Reclaimed oil F.S.: 11,186 GL., No. 2 oil: 7,944

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Wayne L. Bowman | DATE: 9 Sep 93 | APPROVED BY: Randy A. Parks | DATE: 9 Sept 93 | POST ENGINEER | DATE

DA FORM 2067

A.5-91

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO. 1412

MONTH: JULY 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS 2,000 LB. (6)	OIL FUEL USED * GAL (7)	OUTSIDE AVG. TEMP. °F. (8)	NAT. GAS CU. FT (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 4 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220	841	777		1618	167	100	84	695000	3.0	220	14560	7.4	7.4		422	422		380	6	7U		
2	220	842	748		1590	163	100	87	672280	3.1	221	10290	7.4	7.4		422	422		385	6	HEB		
3	220	742	806		1548	168	100	91	441600	3.0	220	14220	7.5	7.4		421	422		384	6	HEB		
4	220	803	780		1583	169	100	88	623590	3.0	220	14180	7.5	7.4		421	422		385	6	HEB		
5	220	816	787		1603	161	100	88	612010	3.0	220	13620	7.5	7.4		421	422		384	6	HEB		
6	220	905	778		1683	173	100	89	655730	3.0	220	13900	7.4	7.4		422	422		384	6	HEB		
7	220	980	786		1764	133	100	87	652800	3.0	220	14670	7.4	7.4		422	422		384	6	FW		
8	220	1035	765		1800	168	100	84	688000	3.0	220	13390	7.4	7.4		422	422		383	6	FW		
9	220	1020	775		1795	140	100	86	637310	3.0	220	14630	7.4	7.4		422	422		385	6	MW		
10	220	999	786		1785	136	100	91	657920	3.0	220	12170	7.4	7.4		422	422		384	6	MW		
11	220	1002	771		1773	137	100	86	662170	3.0	220	12960	7.4	7.4		422	422		382	6	WB		
12	220	966	830		1796	181	100	86	636960	3.0	220	14450	7.4	7.4		422	422		381	6	WB		
13	220	956	824		1780	132	100	86	650250	3.0	220	15640	7.4	7.4		422	422		382	6	WB		
14	220	1048	792		1840	142	100	87	580400	3.0	220	13770	7.4	7.4		422	422		381	6	FW		
15	220	1095	666		1761	150	100	86	491800	3.0	220	14600	7.4	7.5		422	421		382	6	FU		
16	220	1219	662		1821	140	1673	92	402780	3.0	220	16030	7.4	7.5		422	421		384	6	HEB		
17	220	1235	623		1858	147	1394	90	521840	3.0	220	14040	7.4	7.5		422	421		384	6	HEB		
18	220	1283	541		1824	150	1601	91	455250	3.0	220	14160	7.4	7.5		422	421		384	6	HEB		
19	220	1135	646		1781	170	2151	90	548980	3.0	220	13000	7.4	7.5		422	421		385	6	HEB		
20	220	1185	627		1815	138	1938	90	585220	3.0	220	18240	7.4	7.5		422	421		385	6	HEB		
21	220	963	864		1827	169	1360	90	742320	3.0	220	10880	7.4	7.4		422	422		384	6	FW		
22	220	1172	507		1679	174	1450	90	386900	3.0	220	11320	7.4	7.5		422	421		384	6	7U		
23	220	1231	609		1840	143	1567	91	481090	3.4	224	7670	7.4	7.5		422	421		384	6	HEB		
24	220	1167	654		1821	139	1305	93	514850	3.2	223	9840	7.4	7.5		422	421		385	6	HEB		
25	220	1051	731		1782	133	640	90	584900	3.3	223	8500	7.4	7.5		422	421		383	6	HEB		
26	220	1173	646		1818	148	100	87	493110	3.2	222	9750	7.4	7.5		422	421		384	6	HEB		
27	220	1202	626		1828	164	100	86	491790	3.1	221	10090	7.4	7.5		422	422		383	6	HSC		
28	220	1271	597		1868	173	100	86	461330	3.1	221	10370	7.4	7.5		422	421		383	6	W		
29	220	1260	606		1866	172	100	86	450400	3.0	220	11650	7.4	7.5		422	421		383	6	7U		
30	220	1285	575		1860	175	100	88	452400	3.1	221	10470	7.4	7.5		422	421		383	6	HEB		
31	220	1322	555		1874	180	100	84	430130	3.2	222	9570	7.4	7.5		422	421		384	6	HEB		
TOTAL	6820	32309	21680		53989	5415	16256	2730	17527320	94.7	6838	388100	229.7	231.0		13079	13066		11886	186			
MAXIMUM	220	1323	830		1874	181	2151	92	742320	3.4	224	16000	7.5	7.5		422	422		385	6			
MINIMUM	220	742	541		1548	100	100	80	102780	3.0	220	7630	7.4	7.4		421	421		382	6			
AVERAGE	220	1042	699		1742	175	524	88	565397	3.05	220.6	12519	7.41	7.45		421.9	421.5		383	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1949.4, OIL: 90.13, NAT. GAS: ~~7228.26~~ 7228.81

REMARKS: * Reclaimed [illegible] S.: 15,013 GL., NO. 2 OIL: 1,233 480

PREPARED BY: Wayne L. Bowman

DATE: 9 Aug 93

APPROVED BY:

DATE:

POST ENGINEER:

DATE:

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM [illegible]

A.5-92

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: JUNE 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS 2,000 LB. (6)	OIL FUEL USED GAL. * (7)	NAT. GAS C.F. (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 4 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220	996		722	1698	71	1518	818360	82	3.2	223	8000	7.5	7.4	7.4	421	422	422	373	6	WB		
2	220	660		894	1554	71	1120	882790	81	3.2	223	8610	7.6	7.4	7.4	420	422	422	373	6	DR		
3	220	1152		681	1833	68	1555	701220	81	3.3	224	7730	7.4	7.4	7.4	422	422	422	373	6	ER		
4	220	1201	652		1853	67	1665	653343	84	3.2	223	8560	7.4		7.4	422		422	374	6	RLH		
5	220	1059	783		1842	71	684	741870	86	3.3	224	7610	7.5		7.4	421		422	375	6	WB		
6	220	959	778		1737	72	600	611750	83	3.3	224	7600	7.5		7.4	421		422	374	6	WB		
7	220	952	816		1768	70	600	678480	83	3.1	222	[illegible]	7.5		7.4	421		422	374	6	WB		
8	220	1002	746		1748	[illegible]	600	636850	89	3.1	222	10600	7.4		7.4	422		422	376	6	[illegible]		
9	220	977	784		1755	[illegible]	550	639980	93	3.2	223	8590	7.5		7.4	421		422	37[illegible]	6	[illegible]		
10	220	1013	716		1729	100	550	578030	89	3.2	223	9200	7.4		7.4	422		422	37[illegible]	[illegible]	SLB		
11	220	1025	715		1740	91	600	554660	89	3.2	223	8860	7.4		7.4	422		422	[illegible]	6	[illegible]		
12	220	999	749		1748	100	400	582570	84	3.2	223	9080	7.5		7.4	421		422	374	6	MW		
13	220	938	750	60	1748	79	300	619390	81	3.3	224	7880	7.5	7.6	7.4	421	420	422	374	6	WB		
14	220	821	590	291	1702	77	0	546280	76	3.0	220	11640	7.5	7.6	7.5	421	420	421	373	6	MW		
15	220	983	691		1674	65	100	573650	77	3.3	224	7560	7.5		7.4	421		422	373	6	WB		
16	220	1043	670		1713	74	100	55000	78	3.1	221	10910	7.4		7.4	422		422	374	6	ELB		
17	220	939	712		1651	66	200	55000	77	3.1	221	10850	7.5		7.4	421		422	373	6	DR		
18	220	942	684		1626	77	150	528270	77	3.2	222	9320	7.5		7.4	421		422	373	6	WB		
19	220	890	826		1652	63	200	532150	76	3.2	222	9350	7.5		7.4	421		422	373	6	WB		
20	220	817	762		1579	69	200	676250	79	3.2	223	8700	7.5		7.4	421		422	374	6	MW		
21	220	869	799		1668	70	200	684190	84	3.1	221	10800	7.5		7.4	421		422	374	6	WB		
22	220	921	814		1735	63	200	664690	84	3.0	220	19040	7.5		7.4	421		422	374	6	MW		
23	220	925	804		1729	67	200	645740	87	3.0	220	12100	7.5		7.4	421		422	376	6	SLB		
24	220	907	774		1681	72	190	642360	78	3.1	222	9790	7.5		7.4	421		422	37[illegible]	[illegible]	DZ		
25	220	956	806		1762	60	100	716550	[illegible]	3.0	220	12310	7.5		7.4	421		422	37[illegible]	6	TH		
26	220	877	778		1655	69	100	624540	85	3.0	220	11990	7.5		7.4	421		422	375	6	HEB		
27	220	910	765		1675	64	100	582930	85	3.0	220	12960	7.5		7.4	421		422	37[illegible]	[illegible]	HEB		
28	220	917	762		1679	65	100	594580	87	3.0	220	13050	7.5		7.4	421		422	376	6	HEB		
29	220	912	756		1668	64	100	591770	86	3.0	220	14700	7.5		7.4	421		422	376	6	HEB		
30	220	934	754		1683	65	200	628170	84	3.0	220	14900	7.5		7.4	421		422	375	6	FW		
31																							
TOTAL	6600	28[illegible]	20236	2648	53228	2200	13182	19181660	2487	94.1	6657	301180	224.5	37.4	222.1	1264	2106	1266	11231	180			
MAXIMUM	220	1152	826	894	1853	100	1665	882790	93	3.3	224	19070	7.6	7.6	7.5	422	422	422	377	6			
MINIMUM	220	660	590	60	1554	60	100	528270	76	3.0	220	7600	7.4	7.4	7.4	421	420	421	373	6			
AVERAGE	220	951	749	529	1774	73	454	636055	82	3.14	222	10039	7.5	7.5	7.4	421	421	422	374	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 792, OIL: 73.13, NAT. GAS: 374.54

REMARKS: 312260 * RECLAIMED OIL F.S.: 6128 GL.; NO. 2 OIL: 7054

PREPARED BY: [illegible signature] DATE: 4 Jul 93

APPROVED BY: DATE:

POST ENGINEER: DATE:

SEE REVERSE SIDE FOR INSTRUCTIONS

A.5-93

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is the Corps of Engineers.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: MAY 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 4 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS (6)	OIL GAL. * (7)	NAT. GAS C(0)F (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	FEEDWATER HEATER MAKEUP GAL. (12)	% CO2 BOILER 1 (13)	% CO2 BOILER 2 (14)	% CO2 BOILER 4 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS TEMPERATURE BOILER 2 °F. (17)	FLUE GAS TEMPERATURE BOILER 4 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220			1401	1401	183	520	8610	70	3.0	220	13080			7.4			422	370	6	ZU		
2	220			1396	1396	183	420	13820	73	3.0	220	14716			7.4			422	371	6	FW		
3	220			1437	1437	198	490	7490	66	3.0	220	14360			7.4			422	370	6	ZU		
4	220			1375	1375	181	440	16700	71	3.2	223	9040			7.4			422	370	6	AR		
5	220			1402	1402	190	160	3900	78	3.2	223	8880			7.4			422	372	6	ELB		
6	220	20		1364	1384	176	680	25710	77	3.1	222	9600	7.6		7.4	420		422	372	6	PL		
7	220	151		1492	1643	191	820	74500	76	3.2	223	8560	7.6		7.4	420		422	372	6	ZW		
8	220	48		2162	2210	270	1614	17495	71	3.2	223	8050	7.6		7.4	420		422	370	6	FW		
9	220			2067	2067	155	1762	14470	70	3.0	220	11850			7.4			422	370	6	ZU		
10	220			1951	1951	140	1708	14510	72	3.0	220	14050			7.4			422	370	6	FW		
11	220		460	1588	1983	138	2055	25710	72	3.3	224	8020		7.5	7.4		421	422	370	6	ZU		
12	220	1253		785	2038	94	864	1058877	77	3.3	224	7630	7.4		7.4	422		422	373	6	ELB		
13	220	1831		113	1944	9	370	1721150	74	3.4	225	5300	7.4		7.6	422		420	372	6	ELB		
14	220			1970	1970	138	800	4600	72	3.3	224	7960			7.4			422	370	6	ZU		
15	220			1814	1814	128	100	14070	76	3.4	225	6090			7.4			422	372	6	MW		
16	220		68	1739	1807	140	1210		76	3.3	224	6580			7.4			422	372	6	WB		
17	220		701	1239	1940	149	2130	522180	79	3.3	224	6750		7.5	7.5		421	421	373	6	MW		
18	220		555	1346	1901	186	1590	560570	81	3.4	225	3880		7.5	7.4		421	422	374	6	WB		
19	220		60	1924	1984	118	1340	118690	76	3.2	223	8330		7.6	7.4		420	422	372	6	AR		
20	220			1985	1905	101	450	24350	76	3.3	224	6890			7.4			422	372	6	ELB		
21	220			1808	1808	143	120	20080	66	3.1	221	10360			7.4			422	370	6	MW		
22	220			1769	1769	134	520	24590	65	3.3	224	7540			7.4			422	370	6	WB		
23	220			1759	1759	232	540	31900	67	3.3	224	6950			7.4			422	370	6	MW		
24	220			1791	1791	212	920	26510	73	3.4	224	5900			7.4			422	370	6	WB		
25	220		177	1536	1713	201	600	246660	72	3.4	224	6390		7.6	7.4		420	422	370	6	MN		
26	220		552	559	1111	77	500	802470	73	3.4	225	4980		7.5	7.5		421	421	370	6	AR		
27	220		323	1062	1386	138	500	785890	74	3.2	223	8180		7.6	7.5		420	421	371	6	ELB		
28	220		717	962	1679	132	500	761900	73	3.4	224	7010		7.5	7.5		421	421	371	6	WB		
29	220		722	1020	1742	130	600	745860	77	3.2	223	9110		7.5	7.5		421	421	372	6	MW		
30	220		704	1036	1740	100	2507	765960	78	3.4	225	5570		7.5	7.5		421	421	372	6	WB		
31	220		714	991	1705	107	1755	781490	78	3.3	224	7830		7.5	7.5		421	421	372	6	MW		
TOTAL	6820	5117	4976	44758	54851	4674	23583	6812697	2278	100.4	6917	258850	37.6	82.8	230.3	2104	4628	13066	11505	186			
MAXIMUM	220	1831	722	2162	2210	232	2507	802470	81	3.4	225	14716	7.6	7.6	7.6	422	421	422	374	6			
MINIMUM	220	20	60	113	1375	9	100	4600	65	3.0	220	4980	7.4	7.5	7.4	420	420	420	370	6			
AVERAGE	220	852	414	1443	1769	150	922	219764	73	3.2	223	8349	7.5	7.5	7.43	421	420.7	421	371	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1682.64, OIL: 158.58 NAT. GAS: 280.97

REMARKS: * RECLAIMED OIL F.S.: 12,265, NO. 2 OIL: 16318

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: [signature] DATE: 7 Jan 93

APPROVED BY: [signature] DATE: 8 Jun 93

POST ENGINEER: DAVID A. FAGAN, LTC, EN, DEH DATE: 6/8/93

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 50, WHICH WILL BE USED.

A.5-94

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION	PLANT	BLDG. NO.	MONTH
HEADQUARTERS FORT STEWART FORT STEWART, GEORGIA 31313	CENTRAL ENERGY PLANT	1412	APR 1993

DATE	STEAM PRESSURE	STEAM PRODUCED BOILER 1	STEAM PRODUCED BOILER 4	STEAM PRODUCED BOILER 3	STEAM PRODUCED TOTAL	WOOD TONS	OIL *FUEL USED GAL.	NAT. GAS CF	OUTSIDE TEMP. AV.	FEEDWATER HEATER PRESS.	FEEDWATER HEATER TEMP.	FEEDWATER HEATER MAKEUP GAL.	%CO2 BOILER 1	%CO2 BOILER 4	%CO2 BOILER 3	FLUE GAS TEMPERATURE BOILER 1	FLUE GAS TEMPERATURE BOILER 4	FLUE GAS TEMPERATURE BOILER 3	TEMP. H.W. SUPPLY	TUBES CLEANED NUMBER OF TIMES	PREVENT MAINT. CHECK		
	LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.			°F.	LB.	°F.					°F.	°F.	°F.	°F.				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1	220		1534		1534	112	2355	40960	69	3.0	220	11210		7.4			422		370	6	HEB		
2	220		1689		1689	135	2260	27080	55	3.1	221	10680		7.4			422		370	6	DR		
3	220		1828		1828	157	2118	28960	52	3.0	220	12500		7.4			422		370	6	ZU		
4	220		1710		1710	141	2082	7280	57	3.1	221	9920		7.4			422		370	6	FW		
5	220		1760		1760	165	1122	17720	61	3.0	220	13090		7.4			422		370	6	ZU		
6	220		1908		1908	202	700	14280	57	3.0	220	13340		7.4			422		370	6	FW		
7	220		1820		1820	185	340	16500	57	3.2	223	8140		7.4			422		370	6	[illegible]		
8	220		1798		1798	180	490	14450	58	3.1	221	10130		7.4			422		370	6	QJH		
9	220		1737		1737	166	790	15600	64	3.0	220	12190		7.4			422		370	6	ZU		
10	220		1702		1702	169	330	11260	62	3.0	220	12720		7.4			422		370	6	EW		
11	220	56	1546	50	1652	142	630	77500	65	3.0	220	12030	7.6	7.4	7.6	420	422	420	370	6	ZU		
12	220		1642		1642	163	1180	12520	74	3.0	220	14470		7.4			422		371	6	FW		
13	220		1604		1604	155	900	10498	70	3.0	220	14950		7.4			422		370	6	ZU		
14	220	45	1318	85	1448	123	840	126330	74	3.1	221	10090	7.6	7.4	7.6	420	422	420	371	6	ELB		
15	220		1578		1578	141	1008	7080	72	3.0	220	13890		7.4			422		371	6	PL		
16	220		1448		1448	106	2000	8130	68	3.0	220	13901		7.4			422		371	6	ZW		
17	220		1460		1460	113	1730	17150	60	3.0	220	15350		7.4			422		376	6	ZU		
18	220		1475		1475	124	1161	7450	59	3.0	220	13760		7.4			422		370	6	FW		
19	220		1481		1481	128	994	15110	63	3.0	220	16130		7.4			422		370	6	ZU		
20	220		1282	118	1400	92	1472	174936	67	3.0	220	15670		7.4	7.6		422	420	370	6	FW		
21	220		1446		1446	105	2052	14170	66	3.0	220	15070		7.4			422		370	6	QJH		
22	220	50	1440		1490	112	1490	161530	54	3.0	220	12290	7.6	7.4		420	422		370		PL		
23	220		1517		1517	150	360	10310	57	3.0	220	25710		7.4			422		370	6	ZU		
24	220		1456		1456	141	560	8080	65	3.0	220	17530		7.4			422		370	6	FW		
25	220		1445		1445	133	370	19520	68	3.0	220	18320		7.4			422		370	6	ZU		
26	220		1280	245	1525	113	250	157590	67	3.0	220	18150		7.4	7.6		422	420	370	6	EW		
27	220		1398		1398	131	1130	29184	60	3.0	220	21060		7.4			422		370	6	ZU		
28	220		1472		1472	132	230	10520	59	3.0	220	16190		7.4			422		370	6	PL		
29	220		1438		1438	134	290	11630	54	3.0	220	12800		7.4			422		370	6	QJH		
30	220		1417		1417	133	911	12900	64	3.0	220	14530		7.4			422		370		FW		
31												9830											
TOTAL	6600	151	46629	498	47278	4169	32017	1085940	1878	90.7	6607	425981	22.8	222.0	30.4	1260	12660	1280	11103	180			
MAXIMUM	220	56	1908	245	1908	202	2355	174936	74	3.3	223	25710	7.6	7.4	7.6	420	422	420	371	6			
MINIMUM	220	45	1280	50	1398	92	230	7080	52	3.0	220	8140	7.6	7.4	7.6	420	422	420	370	6			
AVERAGE	220	50	1554	125	1576	139	1067	36198	63	3.02	220.2	14193	7.6	7.4	7.6	420	422	420	370.1	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1500.84, OIL: 177.63, NAT. GAS: 44.74

REMARKS: *RECLAIMED OIL FROM F.S. = 20106, NO. 2 OIL = 11911

PREPARED BY	DATE	APPROVED BY	DATE	POST ENGINEER	DATE
Wayne L. B[illegible]	8 MAY 1993				

SEE REVERSE SIDE FOR INSTRUCTIONS

A.5-95

A.5-96

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT | BLDG. NO.: 1412 | MONTH: MAR 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 1 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS 2,000 LB. (6)	OIL FUEL USED GAL. (7)	NAT. GAS (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMP. BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220	125	1659		1784	206	1168	11490	47	3.0	220	18040	7.6	7.4		420	422		370	6	ELB		
2	220	120	430	1000	1630	51	483	726330	49	3.0	220	16740	7.6	7.6	7.4	420	420	422	370	6	FU		
3	220	900		615	1515		987	919030	58	3.0	220	14370	7.4		7.5	422		421	370	6	[illegible]		
4	220	800	80	660	1540	11	150	892450	56	3.0	220	16950	7.4	7.6	7.5	422	420	421	370	6	HEB		
5	220	71	1683		1754	211	1100	52390	51	3.0	220	16710	7.6	7.4		420	422		370	6	ELB		
6	220		1730		1730	227	2012	10020	50	3.0	220	14800		7.4			422		370	6	DR		
7	220		1707		1707	213	667	6350	53	3.0	220	18500		7.4			422		370	6	ELB		
8	220		1552		1552	199	807	12960	59	3.0	220	21990		7.4			422		370	6	DR		
9	220	47	1327		1374	181	436	35080	63	3.0	220	18800	7.6	7.4		420	422		370	6	ELB		
10	220	170	1368		1538	188	360	108780	68	3.0	220	18830	7.6	7.4		420	422		370	6	HEB		
11	220	106	1415		1521	194	490	72530	60	3.0	220	14170	7.6	7.4		420	422		370	6	HEB		
12	220		1780		1780	130	400	9360	56	3.0	220	11060		7.4			422		370	6	DR		
13	220	557	874		1431	120	200	448960	46	3.0	220	13390	7.5	7.5		421	421		370	6	ELB		
14	220		1984		1984	158	440	100	34	3.4	224	6120		7.4			422		370	6	DR		
15	220		2028		2028	163	460	8080	36	3.2	223	9890		7.4			422		370	6	ELB		
16	220		1916		1916	155	470	16190	47	3.2	223	9730		7.4			422		370	6	DR		
17	220		1648		1648	222	270	3159	57	3.4	224	1001		7.4			422		370	6	HEB		
18	220		1717		1717	230	552	21901	49	3.4	224	1095		7.4			422		370	6	HEB		
19	220		1842		1842	231	1354	43860	42	3.3	223	5530		7.4			422		370	6	ELB		
20	220		1440		1440	180	1051	113640	50	3.1	221	9830		7.4			422		370	6	DR		
21	220		1605		1605	200	1217	8210	58	3.0	220	12150		7.4			422		370	6	ELB		
22	220		1737		1737	204	2112	2200	62	3.0	220	14630		7.4			422		370	6	LR		
23	220		1702		1702	211	1427	25780	64	3.0	220	13280		7.4			422		370	6	ELB		
24	220		1689		1689	128	170	7300	66	3.2	222	8670		7.4			422		370	6	[illegible]		
25	220		1687		1687	124	470	16160	72	3.1	221	10170		7.4			422		370	6	[illegible]		
26	220		1761		1761	133	500	11480	56	3.0	220	12720		7.4			422		370	6	[illegible]		
27	220		1715		1715	130	300	22100	62	3.1	221	10550		7.4			422		370	6	DR		
28	220		1714		1714	132	230	9850	64	3.2	222	9700		7.4			422		370	6	[illegible]		
29	220		1698		1698	131	160	15300	65	3.0	220	15510		7.4			422		370	6	DR		
30	220		1648		1648	223	220	13270	68	3.0	220	12660		7.4			422		370	6	[illegible]		
31	220		1629		1629	200	1471	16850	64	3.2	223	8830		7.4			422		370	6	HEB		
TOTAL	6820	2896	46765	2275	51936	5086	22066	3736050	1732	95.8	6851	386410	67.9	222.5	22.0	3785	12655	1264	11470	186			
MAXIMUM	220	900	2028	1000	2028	231	2112	919020	72	3.4	224	21990	7.6	7.6	7.5	422	422	422	370	6			
MINIMUM	220	47	80	615	1379	11	150	100	34	3.0	220	1001	7.4	7.4	7.4	420	420	421	370	6			
AVERAGE	220	322	1559	758	1675	170	712	120518	56	3.1	221	12470	7.54	7.42	7.47	420.6	421.8	421.3	370	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 1830.96, OIL: 122.42, NAT. GAS: 154.07

REMARKS: *Reclaimed Oil From F.S. = 15,889 Gl; No. 2 Oil 6117 gl.

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: [illegible] | DATE: 10 Apr 93 | APPROVED BY | DATE | POST ENGINEER | DATE

A.5-97

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313

PLANT: CENTRAL ENERGY PLANT

BLDG. NO.: 1412

MONTH: FEB 1993

DATE	STEAM PRESSURE	STEAM PRODUCED BOILER 1	BOILER 2	BOILER 3	TOTAL	WOOD TONS	OIL FUEL USED GAL. *	NAT. GAS CU. FT.	OUTSIDE TEMP. AV.	FEEDWATER HEATER PRESS.	FEEDWATER HEATER TEMP.	MAKEUP GAL.	%CO2 BOILER 1	%CO2 BOILER 2	%CO2 BOILER 3	FLUE GAS TEMPERATURE BOILER 1	BOILER 2	BOILER 3	TEMP. H.W. SUPPLY	TUBES CLEANED NUMBER OF TIMES	PREVENT MAINT. CHECK		
	LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	2000 LB.			°F.	LB.	°F.					°F.	°F.	°F.	°F.				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1	220		1697		1697	199	2044	11010	54	3.2	222	9170		7.4			422		370	6	QRH		
2	220		1917		1917	229	2089	13390	41	3.0	220	13540		7.4			422		370	6	PL		
3	220		1939		1939	259	504	26380	42	3.0	220	13330		7.4			422		370	6	EJ		
4	220		1817		1817	250		10020	48	3.1	221	10340		7.4			422		370	6	MW		
5	220		1754		1754	242		7650	49	3.0	220	13000		7.4			422		370	6	QRH		
6	220	50	1688		1738	226		57740	49	3.2	222	8930	7.6	7.4		420	422		370	6	PL		
7	220		1847		1847	254		12720	45	3.0	220	12480		7.4			422		370	6	QRH		
8	220		1898		1898	261		25230	45	3.0	220	11700		7.4			422		370	6	PL		
9	220		1897		1897	261		4910	48	3.0	220	11550		7.4			422		370	6	QRH		
10	220		1871		1871	258		9400	50	3.0	220	13350		7.4			422		370	6	HEB		
11	220		1723		1723	229	500	10640	54	3.0	220	12680		7.4			422		370	6	HEB		
12	220		1804		1804	223	1534	6700	62	3.0	220	13510		7.4			422		370	6	PL		
13	220		1960		1960	243	1606	16690	50	3.0	220	14130		7.4			422		370	6	QRH		
14	220		2023		2023	249	1723	8980	47	3.0	220	13920		7.4			422		370	6	PL		
15	220		2040		2040	251	1803	9640	48	3.0	220	14040		7.4			422		370	6	QRH		
16	220		1875		1875	259		20680	58	3.0	220	18210		7.4			422		370	6	PL		
17	220		2024		2024	280		22898	47	3.0	220	16830		7.4			422		370	6	EJ		
18	220	108	1960		2068	255	1763	89117	40	3.0	220	13790	7.6	7.4		420	422		370	6	MW		
19	220		2108		2108	260	1802	4890	37	3.0	220	16060		7.4			422		370	6	HEB		
20	220		1905		1905	262	1180	11950	48	3.0	220	15080		7.4			422		370	6	DR		
21	220		1658		1658	228		96820	59	3.0	220	16030		7.4			422		370	6	ELB		
22	220	30	1451		1481	199		27140	63	3.0	220	16000	7.6	7.4		420	422		370	6	LR		
23	220		1660		1660	229		10600	52	3.0	220	17780		7.4			422		370	6	ELB		
24	220		1816		1816	250		8192	47	3.0	220	18450		7.4			422		370	6	HEB		
25	220		1916		1916	264		11600	42	3.0	220	17890		7.4			422		370	6	HEB		
26	220	800	200	845	1845	28	11472	9110	45	3.0	220	15120	7.4	7.6	7.4	422	420	422	370	6	LR		
27	220		1873		1873	255		10248	44	3.0	220	14460		7.4			422		370	6	ELB		
28	220		1695		1695	233		57250	44	3.0	220	16250		7.4			422		370	6	LR		
29																							
30																							
31																							
TOTAL	6160	988	50016	845	51849	6888	28020	611070	1358	84.5	6165	400870	30.2	207.4	7.4	1682	11814	422	10360	168			
MAXIMUM	220	800	2108	845	2108	280	11472	96820	63	3.2	222	18450	7.6	7.6	7.4	422	422	422	370	6			
MINIMUM	220	30	1200	845	1481	28	500	4890	37	3.0	220	8930	7.4	7.4	7.4	420	420	422	370	6			
AVERAGE	220	247	1786	845	1852	246	2335	21824	49	3.02	220.2	14317	7.55	7.41	7.4	420.5	421.9	422	370	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2479.68, OIL: 155.45, NAT. GAS: 25.2

REMARKS: 400920 *= RECLAIMED OIL FROM F.S. = 16548 GL., NO.2 OIL = 11472 GL

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: [signature]

DATE: 3 MAR 93

APPROVED BY:

DATE:

POST ENGINEER:

DATE:

A.5-98

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: HEADQUARTERS FORT STEWART, FORT STEWART, GEORGIA 31313 | PLANT: CENTRAL ENERGY PLANT | BLDG. NO.: 1412 | MONTH: JAN 1993

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 4 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	WOOD TONS 2,000 LB. (6)	OIL FUEL USED GAL. * (7)	NAT. GAS CU. FT. (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 4 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 4 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	(22)	(23)
1	220	1305			1305	177	150	12010	61	3.4	224	9460	7.4			422			370	6	HEB		
2	220	1458			1458	197	200	8310	52	3.1	221	10430	7.4			422			370	6	HEB		
3	220	1539			1539	208	200	18080	51	3.0	220	14420	7.4			422			370	6	ET		
4	220	1211	250		1461	164	170	145060	59	3.4	224	6100	7.4	7.6		422	420		370	6	HEB		
5	220	1164			1164	158	150	7890	67	3.1	221	9640	7.4			422			370	6	HEB		
6	220	1179			1179	160	150	5926	66	3.1	221	10480	7.4			422			370	6	FW		
7	220	1198	20	20	1238	147	1053	41540	60	3.0	220	11430	7.4	7.6	7.6	422	420	420	370	6	FU		
8	220	1247			1247	143	1700	4948	65	3.0	220	11100	7.4			422			370	6	HEB		
9	220	1281			1281	140	2190	5030	57	3.1	221	9920	7.4			422			370	6	QXH		
10	220	1578			1578	184	1943	13390	47	3.0	220	16570	7.4			422			370	6	QXH		
11	220	1652			1652	206	1204	1940	49	3.2	223	8230	7.4			422			370	6	QXH		
12	220	1627			1627	220	200	11540	51	3.1	221	10858	7.4			422			370	6	QXH		
13	220	1469			1469	199	170	6350	60	3.0	220	11550	7.4			422			370	6	ET.		
14	220	1602			1602	217	200	540	50	3.1	221	10170	7.4			422			370	6	MW		
15	220	1691			1691	229	210	10460	47	3.1	221	9770	7.4			422			370	6	QXH		
16	220	1696			1696	230	200	10090	46	3.1	221	10350	7.4			422			370	6	QXH		
17	220	1657			1657	225	200	12060	49	3.0	220	11180	7.4			422			370	6	PL		
18	220	1629			1629	221	180	4750	52	3.1	221	9600	7.4			422			370	6	QXH		
19	220	1646			1646	224	170	7980	51	3.0	220	11750	7.4			422			370	6	QXH		
20	220	1850			1850	249	366	13860	43	3.0	220	11790	7.4			422			370	6	ET		
21	220	1565			1565	189	1593	3150	59	3.3	224	6840	7.4			422			370	6	MW		
22	220	917	250	193	1360	100	1485	351830	60	3.3	224	7260	7.4	7.6	7.6	422	420	420	370	6	QXH		
23	220	1511			1511	184	1429	19460	51	3.0	220	11100	7.4			422			370	6	PL		
24	220	1515			1515	184	1380	26380	57	3.2	222	9130	7.4			422			370	6	QXH		
25	220	1757			1757	238	200	4970	43	3.1	221	10330	7.4			422			370	6	PL		
26	220	1857			1857	252	220	17180	40	3.0	220	11960	7.4			422			370	6	QXH		
27	220	1914			1914	260	180	13670	44	3.1	221	10470	7.4			422			370	6	HEB		
28	220	1704			1704	231	206	17360	47	3.1	221	9710	7.4			422			370	6	MW		
29	220	1603			1603	217	290	11510	52	3.1	221	10680	7.4			422			370	6	PL		
30	220	1808			1808	211	2224	11850	48	3.0	220	11010	7.4			422			370	6	QXH		
31	220	1807			1807	244	240	11740	46	3.1	221	10800	7.4			422			370	6	PL		
TOTAL	6820	47637	520	213	48370	6209	20537	830399	1630	96.2	6855	324330	229.4	22.8	15.2	13082	1260		11470	186			
MAXIMUM	220	1914	250	193	1914	260	2224	351830	67	3.5	225	16570	7.4	7.6	7.6	422	420		370	6			
MINIMUM	220	917	20	20	1164	100	150	540	40	3.0	220	6100	7.4	7.6	7.6	422	420		370	6			
AVERAGE	220	1537	173	107	1560	200	662	26786	53	3.1	221	10462	7.4	7.6	7.6	422	420		370	6			

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS): WOOD: 2235.24, OIL: 115.37, NAT. GAS: 34.24

REMARKS: *OIL: Reclaimed Oil From F.S.: 14617, NO. 2 OIL: 5736 324080

PREPARED BY: [signature] DATE: 10 Feb. '93

APPROVED BY: DATE:

POST ENGINEER: DATE:

SEE REVERSE SIDE FOR INSTRUCTIONS

MAKE-UP WATER DATA

A.5-99

Fort Stewart Central Energy Plant
Filename: F-MAKEUP.WQ1

HTW System Makeup Water

Month	Year	WS Makeup Gal(1)	Days/ Month	Avg WS Makeup Gal/Day	Max WS Makeup Gal/Day	Min WS Makeup Gal/Day	Max WS Makeup Gal/Min	Avg WS Makeup Gal/Min	Min WS Makeup Gal/Min
1	93	324080	31	10454	16570	6100	11.5	7.3	4.2
2	93	400920	28	14319	18450	8930	12.8	9.9	6.2
3	93	386430	31	12465	21990	1001	15.3	8.7	0.7
4	93	425830	30	14194	25710	8140	17.9	9.9	5.7
5	93	258830	31	8349	14710	4980	10.2	5.8	3.5
6	93	312260	30	10409	19070	7600	13.2	7.2	5.3
7	93	388480	31	12532	16000	7630	11.1	8.7	5.3
8	93	432570	31	13954	26530	8970	18.4	9.7	6.2
9	93	358820	30	11961	17160	6310	11.9	8.3	4.4
10	93	391750	31	12637	19420	7500	13.5	8.8	5.2
11	93	477570	30	15919	23970	9580	16.6	11.1	6.7
12	93	531190	31	17135	27800	9850	19.3	11.9	6.8
1	94	626020	31	20194	27840	14630	19.3	14.0	10.2
2	94	551230	28	19687	26080	14200	18.1	13.7	9.9
3	94	793890	31	25609	31750	17320	22.0	17.8	12.0
4	94	453420	30	15114	27130	3840	18.8	10.5	2.7
5	94	309740	31	9992	14070	5510	9.8	6.9	3.8
6	94	352590	30	11753	17920	4580	12.4	8.2	3.2
7	94	540670	31	17441	25130	10620	17.5	12.1	7.4
8	94	404010	31	13033	19920	5240	13.8	9.1	3.6
9	94	246270	30	8209	17800	1390	12.4	5.7	1.0
10	94	136380	31	4399	12550	900	8.7	3.1	0.6
11	94	442980	30	14766	23010	1910	16.0	10.3	1.3
12	94	419160	31	13521	20800	7830	14.4	9.4	5.4
1	95	403420	31	13014	17980	8370	12.5	9.0	5.8
2	95	445340	28	15905	25150	11150	17.5	11.0	7.7
3	95	360940	31	11643	18680	7520	13.0	8.1	5.2
4	95	274470	30	9149	14330	5480	10.0	6.4	3.8
5	95	206480	31	6661	11300	2290	7.8	4.6	1.6
6	95	224250	30	7475	11450	4920	8.0	5.2	3.4
7	95	254190	31	8200	11360	3470	7.9	5.7	2.4
8	95	237210	31	7652	10490	5420	7.3	5.3	3.8
9	95	216450	30	7215	11980	3780	8.3	5.0	2.6
10	95	206690	31	6667	12230	3980	8.5	4.6	2.8
11	95	261230	30	8708	16220	2280	11.3	6.0	1.6
12	95	259510	31	8371	12610	4110	8.8	5.8	2.9
3 Yr	Min	136380		4399	10490	900	7.3	3.1	0.6
	Avg	369869		12186	19032	6593	13.2	8.5	4.6
	Max	793890		25609	31750	17320	22.0	17.8	12.0
1993	Min	258830		8349	14710	1001	10.2	5.8	0.7
	Avg	390728		12861	20615	7216	14.3	8.9	5.0
	Max	531190		17135	27800	9850	19.3	11.9	6.8
1994	Min	136380		4399	12550	900	8.7	3.1	0.6
	Avg	439697		14477	22000	7331	15.3	10.1	5.1
	Max	793890		25609	31750	17320	22.0	17.8	12.0
1995	Min	206480		6661	10490	2280	7.3	4.6	1.6
	Avg	279182		9222	14482	5231	10.1	6.4	3.6
	Max	445340		15905	25150	11150	17.5	11.0	7.7

(1) Source is Fort Stewart Boiler Operating Logs.
WS – Water softener makeup water from meter readings.

1995 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	12340			8.6	
	2	14200			9.9	
	3	11070			7.7	
	4	16470			11.4	
	5	14790			10.3	
	6	8750			6.1	
	7	11670			8.1	
	8	11310			7.9	
	9	10650			7.4	
	10	12070			8.4	
	11	8370			5.8	
	12	10090			7.0	
	13	15170			10.5	
	14	13320			9.3	
JAN	15	15450		13014	10.7	9.0
	16	15060			10.5	
	17	15040			10.4	
	18	13900			9.7	
	19	17980			12.5	
	20	14010			9.7	
	21	9440			6.6	
	22	12120			8.4	
	23	16140			11.2	
	24	13080			9.1	
	25	14830			10.3	
	26	13280			9.2	
	27	14760			10.3	
	28	11050			7.7	
	29	11390			7.9	
	30	11720			8.1	
	31	13900	403420		9.7	
*	1	14140			9.8	
*	2	15460			10.7	
	3	14990			10.4	
	4	16660			11.6	
	5	16630			11.5	
	6	12940			9.0	
	7	17370			12.1	
	8	17540			12.2	
	9	19240			13.4	
	10	17320			12.0	
	11	15500			10.8	
	12	14720			10.2	
	13	11430			7.9	
FEB	14	18050		15905	12.5	11.0
	15	25150			17.5	
	16	14280			9.9	
	17	12940			9.0	
	18	11150			7.7	
	19	17920			12.4	
	20	11550			8.0	
	21	15790			11.0	
	22	13680			9.5	
*	23	17120			11.9	
*	24	14610			10.1	
*	25	16360			11.4	
*	26	15940			11.1	
*	27	24830			17.2	
	28	12030	445340		8.4	

– ANNUAL STATS –

AVG GPM	6.4
MIN GPM	1.6
MAX GPM	17.5
STD DEV	2.5
VARIANC	6.0

FREQUENCY:

GPM	NO. DAYS
0	0
1	0
2	3
3	15
4	31
5	62
6	81
7	55
8	40
9	22
10	20
11	18
12	8
13	7
14	1
15	0
16	0
17	0
18	2
19	0
20	0
21	0
22	0
23	0
24	0
25	0

1995 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	18680			13.0	
	2	13870			9.6	
	3	7820			5.4	
	4	11000			7.6	
	5	13170			9.1	
	6	10400			7.2	
	7	9140			6.3	
	8	11970			8.3	
	9	14280			9.9	
	10	7520			5.2	
	11	11230			7.8	
	12	14350			10.0	
	13	12910			9.0	
	14	9820			6.8	
MAR	15	12110		11643	8.4	8.1
	16	11250			7.8	
	17	13110			9.1	
	18	9570			6.6	
	19	9070			6.3	
	20	8530			5.9	
	21	9400			6.5	
	22	13730			9.5	
	23	12560			8.7	
	24	14620			10.2	
	25	11200			7.8	
	26	13030			9.0	
	27	11740			8.2	
	28	12100			8.4	
	29	10120			7.0	
	30	8060			5.6	
	31	14580	360940		10.1	
	1	14330			10.0	
	2	9910			6.9	
	3	11410			7.9	
	4	11550			8.0	
	5	9830			6.8	
	6	12590			8.7	
	7	9140			6.3	
	8	10320			7.2	
	9	10890			7.6	
	10	10450			7.3	
	11	7720			5.4	
	12	7590			5.3	
	13	11020			7.7	
	14	10580			7.3	
APR	15	6900		9149	4.8	6.4
	16	8440			5.9	
	17	7340			5.1	
	18	8490			5.9	
	19	8670			6.0	
	20	9790			6.8	
	21	7940			5.5	
	22	10940			7.6	
	23	8580			6.0	
	24	10600			7.4	
	25	7940			5.5	
	26	5740			4.0	
	27	6000			4.2	
	28	6450			4.5	
	29	7840			5.4	
	30	5480	274470		3.8	

1995 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	5980			4.2	
	2	6010			4.2	
	3	8030			5.6	
	4	5320			3.7	
	5	4060			2.8	
	6	4220			2.9	
	7	3010			2.1	
	8	6450			4.5	
	9	3750			2.6	
	10	8950			6.2	
	11	8110			5.6	
	12	8800			6.1	
	13	6440			4.5	
	14	10390			7.2	
MAY	15	2290		6661	1.6	4.6
	16	11300			7.8	
	17	7640			5.3	
	18	5090			3.5	
	19	7570			5.3	
	20	7480			5.2	
	21	7700			5.3	
	22	6610			4.6	
	23	5550			3.9	
	24	7630			5.3	
	25	8710			6.0	
	26	4480			3.1	
	27	6470			4.5	
	28	8600			6.0	
	29	6160			4.3	
	30	7890			5.5	
	31	5790	206480		4.0	
	1	7500			5.2	
	2	6180			4.3	
	3	5920			4.1	
	4	8410			5.8	
	5	7600			5.3	
	6	9190			6.4	
	7	8430			5.9	
	8	5840			4.1	
	9	5910			4.1	
	10	5520			3.8	
	11	8310			5.8	
	12	9230			6.4	
	13	11450			8.0	
	14	6480			4.5	
JUN	15	5440		7475	3.8	5.2
	16	7380			5.1	
	17	8080			5.6	
	18	7860			5.5	
	19	5700			4.0	
	20	5630			3.9	
	21	6830			4.7	
	22	9310			6.5	
	23	9960			6.9	
	24	7900			5.5	
	25	7090			4.9	
	26	6240			4.3	
	27	8960			6.2	
	28	9520			6.6	
	29	7460			5.2	
	30	4920	224250		3.4	

1995 DAILY MAKEUP WATER

MONT	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	4430			3.1	
	2	10620			7.4	
	3	3470			2.4	
	4	6990			4.9	
	5	6240			4.3	
	6	7810			5.4	
	7	7480			5.2	
	8	8010			5.6	
	9	9520			6.6	
	10	8050			5.6	
	11	6780			4.7	
	12	9470			6.6	
	13	4470			3.1	
	14	5610			3.9	
JUL	15	8480		8200	5.9	5.7
	16	8390			5.8	
	17	7710			5.4	
	18	7640			5.3	
	19	9320			6.5	
	20	9930			6.9	
	21	9370			6.5	
	22	9080			6.3	
	23	7480			5.2	
	24	8180			5.7	
	25	11360			7.9	
	26	11130			7.7	
*	27	9760			6.8	
	28	10420			7.2	
	29	8090			5.6	
	30	9080			6.3	
	31	9820	254190		6.8	
	1	8710			6.0	
	2	9470			6.6	
	3	9580			6.7	
	4	7020			4.9	
	5	10200			7.1	
	6	8420			5.8	
	7	10430			7.2	
	8	7210			5.0	
	9	5910			4.1	
	10	7260			5.0	
	11	6470			4.5	
	12	8320			5.8	
	13	6970			4.8	
	14	6640			4.6	
AUG	15	8410		7652	5.8	5.3
	16	7340			5.1	
	17	6900			4.8	
	18	7630			5.3	
	19	6560			4.6	
	20	5820			4.0	
	21	8020			5.6	
	22	5420			3.8	
	23	5720			4.0	
	24	6840			4.8	
	25	10490			7.3	
	26	7220			5.0	
	27	8840			6.1	
	28	8430			5.9	
	29	7290			5.1	
	30	6740			4.7	
	31	6930	237210		4.8	

1995 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	6230			4.3	
	2	7940			5.5	
	3	8070			5.6	
	4	7700			5.3	
	5	7500			5.2	
	6	8860			6.2	
	7	5560			3.9	
	8	10300			7.2	
	9	7020			4.9	
	10	8560			5.9	
	11	6130			4.3	
	12	6120			4.3	
	13	6990			4.9	
	14	11980			8.3	
SEP	15	6280		7215	4.4	5.0
	16	8570			6.0	
	17	7990			5.5	
	18	8650			6.0	
	19	8510			5.9	
	20	9720			6.8	
	21	7250			5.0	
	22	6760			4.7	
	23	4550			3.2	
	24	6280			4.4	
	25	6330			4.4	
	26	3780			2.6	
	27	4080			2.8	
	28	7400			5.1	
	29	5020			3.5	
	30	6320	216450		4.4	
	1	4280			3.0	
	2	4230			2.9	
	3	6570			4.6	
	4	6580			4.6	
	5	6180			4.3	
	6	5740			4.0	
	7	7050			4.9	
	8	6500			4.5	
*	9	5970			4.1	
	10	10080			7.0	
	11	12230			8.5	
	12	6710			4.7	
	13	7390			5.1	
*	14	11110			7.7	
OCT	15	7610		6667	5.3	4.6
	16	8260			5.7	
	17	5620			3.9	
	18	6820			4.7	
	19	7070			4.9	
	20	7160			5.0	
	21	7740			5.4	
	22	7410			5.1	
	23	6120			4.3	
	24	4970			3.5	
	25	5040			3.5	
	26	5710			4.0	
	27	6750			4.7	
	28	4370			3.0	
	29	3980			2.8	
	30	6330			4.4	
	31	5110	206690		3.5	

1995 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	4020			2.8	
	2	5090			3.5	
	3	3730			2.6	
	4	7330			5.1	
	5	2280			1.6	
	6	7650			5.3	
	7	2440			1.7	
	8	3700			2.6	
	9	9110			6.3	
	10	10140			7.0	
	11	5410			3.8	
	12	6830			4.7	
	13	10080			7.0	
	14	9320			6.5	
NOV	15	12200		8708	8.5	6.0
	16	13450			9.3	
	17	16220			11.3	
	18	14560			10.1	
	19	10130			7.0	
	20	13380			9.3	
	21	14530			10.1	
	22	14460			10.0	
	23	10020			7.0	
	24	7950			5.5	
	25	11720			8.1	
	26	4100			2.8	
	27	4450			3.1	
	28	10070			7.0	
	29	9450			6.6	
	30	7410	261230		5.1	
	1	7430			5.2	
	2	9300			6.5	
	3	10090			7.0	
	4	8930			6.2	
	5	9170			6.4	
	6	6500			4.5	
	7	9930			6.9	
	8	7770			5.4	
	9	7430			5.2	
	10	9410			6.5	
	11	9100			6.3	
	12	8010			5.6	
	13	9780			6.8	
	14	9470			6.6	
DEC	15	10930		8371	7.6	5.8
	16	8650			6.0	
	17	9770			6.8	
	18	8500			5.9	
	19	6790			4.7	
	20	7300			5.1	
	21	7620			5.3	
	22	4110			2.9	
	23	6220			4.3	
	24	7180			5.0	
	25	4420			3.1	
	26	5050			3.5	
	27	7010			4.9	
	28	9310			6.5	
	29	10690			7.4	
	30	11030			7.7	
	31	12610	259510		8.8	

1994 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	19660			13.7	
	2	22970			16.0	
	3	27360			19.0	
	4	14630			10.2	
	5	15970			11.1	
	6	19580			13.6	
	7	24220			16.8	
	8	25780			17.9	
	9	26590			18.5	
	10	26270			18.2	
	11	27840			19.3	
	12	22680			15.8	
	13	22050			15.3	
	14	15020			10.4	
JAN	15	21080		20194	14.6	14.0
	16	22930			15.9	
	17	17550			12.2	
	18	20730			14.4	
	19	23850			16.6	
	20	22130			15.4	
	21	18870			13.1	
	22	18690			13.0	
	23	16020			11.1	
	24	19140			13.3	
	25	17180			11.9	
	26	14130			9.8	
	27	17120			11.9	
	28	16350			11.4	
	29	17580			12.2	
	30	14480			10.1	
	31	17570	626020		12.2	
	1	14200			9.9	
	2	17160			11.9	
	3	17440			12.1	
	4	15090			10.5	
	5	15960			11.1	
	6	20770			14.4	
	7	15340			10.7	
	8	17870			12.4	
	9	19420			13.5	
	10	18420			12.8	
	11	20090			14.0	
	12	19010			13.2	
	13	18160			12.6	
FEB	14	21660		19687	15.0	13.7
	15	20380			14.2	
	16	23820			16.5	
	17	20440			14.2	
	18	16770			11.6	
	19	20080			13.9	
	20	25150			17.5	
	21	21440			14.9	
	22	21490			14.9	
	23	26080			18.1	
	24	22740			15.8	
	25	21170			14.7	
	26	21720			15.1	
	27	19240			13.4	
	28	20120	551230		14.0	

– ANNUAL STATS –

AVG GPM	10.0
MIN GPM	0.6
MAX GPM	22.0
STD DEV	4.7
VARIANC	22.1

FREQUENCY:

GPM	NO. DAYS
0	0
1	5
2	18
3	3
4	9
5	9
6	25
7	35
8	36
9	25
10	25
11	24
12	25
13	28
14	21
15	16
16	18
17	14
18	8
19	10
20	7
21	1
22	2
23	1
24	0
25	0

1994 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	25100			17.4	
	2	20320			14.1	
	3	23790			16.5	
	4	22910			15.9	
	5	17320			12.0	
	6	25540			17.7	
	7	23860			16.6	
	8	22170			15.4	
	9	20290			14.1	
	10	26490			18.4	
	11	28540			19.8	
	12	23920			16.6	
	13	23450			16.3	
	14	27460			19.1	
MAR	15	25260		25609	17.5	17.8
	16	26090			18.1	
	17	26040			18.1	
	18	23560			16.4	
	19	24360			16.9	
	20	29390			20.4	
	21	28510			19.8	
	22	26570			18.5	
	23	28150			19.5	
	24	27000			18.8	
	25	31750			22.0	
	26	24160			16.8	
	27	27560			19.1	
	28	31250			21.7	
	29	31630			22.0	
	30	28450			19.8	
	31	23000	793890		16.0	
	1	22740			15.8	
	2	27130			18.8	
	3	22670			15.7	
	4	22190			15.4	
	5	23930			16.6	
	6	24730			17.2	
	7	24140			16.8	
	8	20050			13.9	
	9	22500			15.6	
	10	21360			14.8	
	11	25540			17.7	
	12	16220			11.3	
	13	24130			16.8	
	14	10810			7.5	
APR	15	4740		15114	3.3	10.5
	16	4500			3.1	
	17	10250			7.1	
	18	10280			7.1	
	19	13500			9.4	
	20	10280			7.1	
	21	8250			5.7	
	22	3840			2.7	
	23	4600			3.2	
	24	10260			7.1	
	25	9830			6.8	
	26	10130			7.0	
	27	10010			7.0	
	28	7180			5.0	
	29	13110			9.1	
	30	14520	453420		10.1	

1994 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	9870			6.9	
	2	14070			9.8	
	3	7580			5.3	
	4	9980			6.9	
	5	11910			8.3	
	6	7940			5.5	
	7	12030			8.4	
	8	9730			6.8	
	9	8760			6.1	
	10	9730			6.8	
	11	11390			7.9	
	12	8350			5.8	
	13	9510			6.6	
	14	11480			8.0	
MAY	15	8280		9992	5.8	6.9
	16	5680			3.9	
	17	10250			7.1	
	18	7530			5.2	
	19	9460			6.6	
	20	11870			8.2	
	21	12320			8.6	
	22	11510			8.0	
	23	8470			5.9	
	24	12550			8.7	
	25	9700			6.7	
	26	10950			7.6	
	27	10170			7.1	
	28	7960			5.5	
	29	9910			6.9	
	30	8850			6.1	
	31	11950	309740		8.3	
	1	7550			5.2	
	2	13240			9.2	
	3	10770			7.5	
	4	10470			7.3	
	5	8960			6.2	
	6	9080			6.3	
	7	11300			7.8	
	8	9000			6.3	
	9	4580			3.2	
	10	8000			5.6	
	11	9520			6.6	
	12	11130			7.7	
	13	12140			8.4	
	14	9190			6.4	
JUN	15	12370		11753	8.6	8.2
	16	11090			7.7	
	17	14450			10.0	
	18	11890			8.3	
	19	11050			7.7	
	20	14080			9.8	
	21	14310			9.9	
	22	17920			12.4	
	23	9720			6.8	
	24	15530			10.8	
	25	14020			9.7	
	26	15320			10.6	
	27	14220			9.9	
	28	14180			9.8	
	29	12200			8.5	
	30	15310	352590		10.6	

1994 DAILY MAKEUP WATER

MONT	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	12920			9.0	
	2	15930			11.1	
	3	12250			8.5	
	4	12760			8.9	
	5	13570			9.4	
	6	10620			7.4	
	7	21960			15.3	
	8	14500			10.1	
	9	18370			12.8	
	10	15400			10.7	
	11	17130			11.9	
	12	17310			12.0	
	13	25130			17.5	
	14	21390			14.9	
JUL	15	13200		17441	9.2	12.1
	16	18480			12.8	
	17	17870			12.4	
	18	18070			12.5	
	19	20870			14.5	
	20	18490			12.8	
	21	21440			14.9	
	22	17360			12.1	
	23	17800			12.4	
	24	15020			10.4	
	25	20240			14.1	
	26	18840			13.1	
	27	17160			11.9	
	28	19530			13.6	
	29	16960			11.8	
	30	23240			16.1	
	31	16860	540670		11.7	
	1	19920			13.8	
	2	17770			12.3	
	3	18120			12.6	
	4	19050			13.2	
	5	13080			9.1	
	6	13540			9.4	
	7	16090			11.2	
	8	17210			12.0	
	9	16420			11.4	
	10	12430			8.6	
	11	17110			11.9	
	12	14850			10.3	
	13	15990			11.1	
	14	15020			10.4	
AUG	15	18590		13033	12.9	9.1
	16	17880			12.4	
	17	13990			9.7	
	18	11160			7.8	
	19	5240			3.6	
	20	9080			6.3	
	21	10430			7.2	
	22	9310			6.5	
	23	6640			4.6	
	24	11450			8.0	
	25	8500			5.9	
	26	5730			4.0	
	27	9470			6.6	
	28	11630			8.1	
	29	12460			8.7	
	30	8540			5.9	
	31	7310	404010		5.1	

1994 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	6740			4.7	
	2	10850			7.5	
	3	7990			5.5	
	4	7390			5.1	
	5	5060			3.5	
	6	17800			12.4	
	7	9440			6.6	
	8	10420			7.2	
	9	8540			5.9	
	10	8200			5.7	
	11	8060			5.6	
	12	8320			5.8	
	13	5600			3.9	
	14	2070			1.4	
SEP	15	6840		8209	4.8	5.7
	16	6950			4.8	
	17	7080			4.9	
	18	6980			4.8	
	19	9150			6.4	
	20	8690			6.0	
	21	8030			5.6	
	22	9870			6.9	
	23	9440			6.6	
	24	9970			6.9	
	25	1390			1.0	
	26	9570			6.6	
	27	9170			6.4	
	28	10480			7.3	
	29	8210			5.7	
	30	7970	246270		5.5	
	1	7050			4.9	
	2	9190			6.4	
	3	10300			7.2	
	4	6730			4.7	
	5	8520			5.9	
	6	12550			8.7	
	7	11210			7.8	
	8	10010			7.0	
	9	9920			6.9	
	10	9460			6.6	
	11	2120			1.5	
	12	900			0.6	
	13	1600			1.1	
	14	1260			0.9	
OCT	15	2660		4399	1.8	3.1
	16	2470			1.7	
	17	1840			1.3	
	18	2330			1.6	
	19	2140			1.5	
	20	1900			1.3	
	21	1730			1.2	
	22	3020			2.1	
	23	1390			1.0	
	24	2520			1.8	
	25	1950			1.4	
	26	2320			1.6	
	27	1830			1.3	
	28	1870			1.3	
	29	2140			1.5	
	30	950			0.7	
	31	2500	136380		1.7	

1994 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	4120			2.9	
	2	1910			1.3	
	3	13180			9.2	
	4	16220			11.3	
	5	15080			10.5	
	6	14900			10.3	
	7	12210			8.5	
	8	15360			10.7	
	9	18450			12.8	
	10	16470			11.4	
	11	13860			9.6	
	12	14480			10.1	
	13	13250			9.2	
	14	19840			13.8	
NOV	15	22030		14766	15.3	10.3
	16	11030			7.7	
	17	23010			16.0	
	18	12580			8.7	
	19	18870			13.1	
	20	18640			12.9	
	21	14180			9.8	
	22	17650			12.3	
	23	18870			13.1	
	24	13150			9.1	
	25	12510			8.7	
	26	13890			9.6	
	27	12370			8.6	
	28	14820			10.3	
	29	13580			9.4	
	30	16470	442980		11.4	
	1	16310			11.3	
	2	17750			12.3	
	3	12720			8.8	
	4	13390			9.3	
	5	16600			11.5	
	6	18870			13.1	
	7	10970			7.6	
	8	11670			8.1	
	9	10380			7.2	
	10	14540			10.1	
	11	11660			8.1	
	12	15560			10.8	
	13	8080			5.6	
	14	10740			7.5	
DEC	15	10810		13521	7.5	9.4
	16	13500			9.4	
	17	10170			7.1	
	18	10410			7.2	
	19	10490			7.3	
	20	19250			13.4	
	21	19410			13.5	
	22	15300			10.6	
	23	7830			5.4	
	24	10840			7.5	
	25	12690			8.8	
	26	9980			6.9	
	27	17900			12.4	
	28	16480			11.4	
	29	20800			14.4	
	30	9540			6.6	
	31	14520	419160		10.1	

1993 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	9460			6.6	
	2	10430			7.2	
	3	14420			10.0	
	4	6100			4.2	
	5	9640			6.7	
	6	10480			7.3	
	7	11430			7.9	
	8	11100			7.7	
	9	9920			6.9	
	10	16570			11.5	
	11	8230			5.7	
	12	10850			7.5	
	13	11550			8.0	
	14	10170			7.1	
JAN	15	9770		10454	6.8	7.3
	16	10350			7.2	
	17	11180			7.8	
	18	9600			6.7	
	19	11750			8.2	
	20	11790			8.2	
	21	6840			4.8	
	22	7260			5.0	
	23	11100			7.7	
	24	9130			6.3	
	25	10330			7.2	
	26	11960			8.3	
	27	10470			7.3	
	28	9710			6.7	
	29	10680			7.4	
	30	11010			7.6	
	31	10800	324080		7.5	
	1	9170			6.4	
	2	13540			9.4	
	3	13330			9.3	
	4	10340			7.2	
	5	13000			9.0	
	6	8930			6.2	
	7	12480			8.7	
	8	11700			8.1	
	9	11550			8.0	
	10	13350			9.3	
	11	12680			8.8	
	12	13510			9.4	
	13	14130			9.8	
FEB	14	13920		14319	9.7	9.9
	15	14040			9.8	
	16	18210			12.6	
	17	16830			11.7	
	18	13790			9.6	
	19	16060			11.2	
	20	15080			10.5	
	21	16030			11.1	
	22	16000			11.1	
	23	17780			12.3	
	24	18450			12.8	
	25	17890			12.4	
	26	18420			12.8	
	27	14460			10.0	
	28	16250	400920		11.3	

– ANNUAL STATS –

AVG GPM	8.9
MIN GPM	0.7
MAX GPM	19.3
STD DEV	2.9
VARIANC	8.3

FREQUENCY:

GPM	NO. DAYS
0	0
1	2
2	0
3	1
4	4
5	12
6	27
7	44
8	60
9	54
10	54
11	34
12	22
13	23
14	7
15	6
16	4
17	6
18	2
19	2
20	1
21	0
22	0
23	0
24	0
25	0

1993 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	18040			12.5	
	2	16750			11.6	
	3	14370			10.0	
	4	16950			11.8	
	5	16710			11.6	
	6	14800			10.3	
	7	18500			12.8	
	8	21990			15.3	
	9	18800			13.1	
	10	18830			13.1	
	11	14170			9.8	
	12	11060			7.7	
	13	13390			9.3	
	14	6120			4.3	
MAR	15	9890		12465	6.9	8.7
	16	9730			6.8	
	17	1000			0.7	
	18	1100			0.8	
	19	5530			3.8	
	20	9830			6.8	
	21	12150			8.4	
	22	14630			10.2	
	23	13280			9.2	
	24	8670			6.0	
	25	10170			7.1	
	26	12720			8.8	
	27	10550			7.3	
	28	9700			6.7	
	29	15510			10.8	
	30	12660			8.8	
	31	8830	386430		6.1	
	1	11210			7.8	
	2	10680			7.4	
	3	12500			8.7	
	4	9920			6.9	
	5	13090			9.1	
	6	13340			9.3	
	7	8140			5.7	
	8	10130			7.0	
	9	12190			8.5	
	10	12720			8.8	
	11	12030			8.4	
	12	14470			10.0	
	13	14950			10.4	
	14	10090			7.0	
APR	15	13890		14194	9.6	9.9
	16	13900			9.7	
	17	15350			10.7	
	18	13760			9.6	
	19	16130			11.2	
	20	15670			10.9	
	21	15070			10.5	
	22	12290			8.5	
	23	25730			17.9	
	24	17530			12.2	
	25	18320			12.7	
	26	18150			12.6	
	27	21060			14.6	
	28	16190			11.2	
	29	12800			8.9	
	30	14530	425830		10.1	

1993 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	13080			9.1	
	2	14710			10.2	
	3	14360			10.0	
	4	9040			6.3	
	5	8880			6.2	
	6	9600			6.7	
	7	8560			5.9	
	8	8050			5.6	
	9	11450			8.0	
	10	14050			9.8	
	11	8020			5.6	
	12	7630			5.3	
	13	5300			3.7	
	14	7960			5.5	
MAY	15	6090		8349	4.2	5.8
	16	6380			4.4	
	17	6750			4.7	
	18	3880			2.7	
	19	8330			5.8	
	20	6890			4.8	
	21	10360			7.2	
	22	7540			5.2	
	23	6950			4.8	
	24	5900			4.1	
	25	6390			4.4	
	26	4980			3.5	
	27	8180			5.7	
	28	7010			4.9	
	29	9110			6.3	
	30	5570			3.9	
	31	7830	258830		5.4	
	1	8000			5.6	
	2	8610			6.0	
	3	7730			5.4	
	4	8560			5.9	
	5	7600			5.3	
	6	7600			5.3	
	7	10380			7.2	
	8	10600			7.4	
	9	8590			6.0	
	10	9200			6.4	
	11	8860			6.2	
	12	9080			6.3	
	13	7880			5.5	
	14	11640			8.1	
JUN	15	7560		10409	5.3	7.2
	16	10910			7.6	
	17	10850			7.5	
	18	9320			6.5	
	19	9350			6.5	
	20	8700			6.0	
	21	10800			7.5	
	22	19040			13.2	
	23	12100			8.4	
	24	9390			6.5	
	25	12310			8.5	
	26	11990			8.3	
	27	12960			9.0	
	28	13050			9.1	
	29	14700			10.2	
	30	14900	312260		10.3	

1993 DAILY MAKEUP WATER

MONT	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	14560			10.1	
	2	10290			7.1	
	3	14220			9.9	
	4	14180			9.8	
	5	13620			9.5	
	6	13900			9.7	
	7	14670			10.2	
	8	13390			9.3	
	9	14630			10.2	
	10	12170			8.5	
	11	12960			9.0	
	12	14450			10.0	
	13	15640			10.9	
	14	13770			9.6	
JUL	15	14600		12532	10.1	8.7
	16	16030			11.1	
	17	14040			9.8	
	18	14160			9.8	
	19	13000			9.0	
	20	14240			9.9	
	21	10830			7.5	
	22	11320			7.9	
	23	7630			5.3	
	24	9840			6.8	
	25	8500			5.9	
	26	9750			6.8	
	27	10090			7.0	
	28	10370			7.2	
	29	11650			8.1	
	30	10470			7.3	
	31	9510	388480		6.6	
	1	10560			7.3	
	2	12220			8.5	
	3	10070			7.0	
	4	10050			7.0	
	5	8970			6.2	
	6	10750			7.5	
	7	10480			7.3	
	8	15120			10.5	
	9	13750			9.5	
	10	12340			8.6	
	11	12470			8.7	
	12	11780			8.2	
	13	11900			8.3	
	14	10400			7.2	
AUG	15	11780		13954	8.2	9.7
	16	10050			7.0	
	17	12320			8.6	
	18	11710			8.1	
	19	16480			11.4	
	20	11350			7.9	
	21	10950			7.6	
	22	14100			9.8	
	23	12340			8.6	
	24	15240			10.6	
	25	16510			11.5	
	26	18270			12.7	
	27	17960			12.5	
	28	21740			15.1	
	29	21140			14.7	
	30	26530			18.4	
	31	23240	432570		16.1	

1993 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	13990			9.7	
	2	11990			8.3	
	3	12520			8.7	
	4	10900			7.6	
	5	12610			8.8	
	6	15450			10.7	
	7	12290			8.5	
	8	9010			6.3	
	9	12550			8.7	
	10	10250			7.1	
	11	13230			9.2	
	12	12150			8.4	
	13	14510			10.1	
	14	13360			9.3	
SEP	15	13840		11961	9.6	8.3
	16	12930			9.0	
	17	8570			6.0	
	18	12550			8.7	
	19	10440			7.3	
	20	6310			4.4	
	21	11060			7.7	
	22	10510			7.3	
	23	9220			6.4	
	24	8430			5.9	
	25	17800			12.4	
	26	15760			10.9	
	27	10750			7.5	
	28	10540			7.3	
	29	17160			11.9	
	30	8140	358820		5.7	
	1	12050			8.4	
	2	9800			6.8	
	3	13030			9.0	
	4	9870			6.9	
	5	10180			7.1	
	6	17930			12.5	
	7	11340			7.9	
	8	9940			6.9	
	9	12920			9.0	
	10	12930			9.0	
	11	11560			8.0	
	12	13700			9.5	
	13	11490			8.0	
	14	9810			6.8	
OCT	15	11030		12637	7.7	8.8
	16	10470			7.3	
	17	13630			9.5	
	18	12970			9.0	
	19	16120			11.2	
	20	16440			11.4	
	21	16250			11.3	
	22	9730			6.8	
	23	12270			8.5	
	24	11200			7.8	
	25	7500			5.2	
	26	13800			9.6	
	27	13280			9.2	
	28	13230			9.2	
	29	13790			9.6	
	30	14070			9.8	
	31	19420	391750		13.5	

1993 DAILY MAKEUP WATER

MONTH	DAY	GAL/DAY	TOTAL	AVG GPD	GAL/MIN	AVG GPM
	1	19980			13.9	
	2	23710			16.5	
	3	23970			16.6	
	4	23280			16.2	
	5	19300			13.4	
	6	9580			6.7	
	7	15810			11.0	
	8	20750			14.4	
	9	18250			12.7	
	10	10340			7.2	
	11	24770			17.2	
	12	14190			9.9	
	13	17460			12.1	
	14	24400			16.9	
NOV	15	20310		15919	14.1	11.1
	16	16900			11.7	
	17	14650			10.2	
	18	12120			8.4	
	19	9870			6.9	
	20	13190			9.2	
	21	11260			7.8	
	22	10090			7.0	
	23	11110			7.7	
	24	14170			9.8	
	25	12560			8.7	
	26	15940			11.1	
	27	12950			9.0	
	28	12990			9.0	
	29	12610			8.8	
	30	11060	477570		7.7	
	1	15770			11.0	
	2	9850			6.8	
	3	15310			10.6	
	4	14900			10.3	
	5	13840			9.6	
	6	12440			8.6	
	7	12290			8.5	
	8	11900			8.3	
	9	10640			7.4	
	10	15020			10.4	
	11	13230			9.2	
	12	17440			12.1	
	13	18190			12.6	
	14	17800			12.4	
DEC	15	24350		17135	16.9	11.9
	16	13560			9.4	
	17	14870			10.3	
	18	14830			10.3	
	19	16290			11.3	
	20	17460			12.1	
	21	18540			12.9	
	22	16060			11.2	
	23	17860			12.4	
	24	19890			13.8	
	25	17650			12.3	
	26	22880			15.9	
	27	21180			14.7	
	28	27800			19.3	
	29	26840			18.6	
	30	21960			15.3	
	31	20550	531190		14.3	

A.6 ANALYSIS OF HTW AND DHW SAMPLES

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Telephone Call Confirmation

Date:	April 29, 1996		
Project Number:	694-1331-002		
Project Name:	Fort Stewart HTW Study		
Received:		**Placed:**	by W. T. Todd
Local:		**Long Dist.:**	303-674-9897
Conversed with:	John Tiangco		
of	Puckorius & Assoc. Water & Environmental Mgmt. Consultants		
Regarding:	Fort Stewart Boiler and HTW System Water Quality		

To control general corrosion the pH and causticity should be kept high within the control range. Causticity is related to pH. Low pH is acidic and high pH is basic. Morpholine is added to the make-up water to raise the pH.

To control pitting corrosion the sulfite should be kept high within the control range. Sodium sulfite is added to the make-up water to tie up the oxygen. The high sulfite in the boiler is probably due to trying to control the HTW system sulfite with boiler feed water treatment. They recommend separate chemical feed systems. High sulfite levels do not adversely affect the system, however, it is a waste of chemicals.

The total dissolved solids (TDS) is mostly sodium which is benign. TDS is directly related to quantity of blowdown so they could reduce their blowdown by approximately 50 percent. Causticity goes up when blow down is reduced. Probably due to high alkalinity in the make-up water. When blow down is reduced the alkalinity, pH and causticity cycle up within the boiler. He thinks a de-alkalizer (similar to a water softener) would remove the bad alkalinity from the make-up water and would solve this problem. The cost would be similar to a water softener.

Water hardness is mostly calcium and some magnesium. Water softener removes most of the calcium and magnesium from make-up water. Phosphate is added to the make-up water to tie up any remaining calcium and magnesium.

Distribution: Fort Stewart File　　By: William T. Todd, PE

BOILER SYSTEM WATER ANALYSIS PROGRAM

FORT STEWART BUILDING 1412 BOILER 4

Sample Number . . . . . XCSTEWBW
Date Sampled 07/18/95
Date Received 08/14/95
Date Analyzed 08/17/95
Date Report Issued . 08/25/95

Boiler Water Analysis Report

Test Description	P&A	Plant	Control
Specific Sx Description			
Total Hardness, ppm $CaCO_3$	<2		
Filt Ortho Phos, ppm PO_4	23	35	30 - 60
Polymer, ppm			N/A
Sulfite, ppm Na_2SO_3	549	800	20 - 40
P Alkalinity, ppm $CaCO_3$	360		
Causticity, ppm OH^-	120	115	20 - 200
pH	11.3	11.3	
Neut Conductivity, mmhos	2000	2200	
Total Diss Solids, ppm	1400	1540	3000 - 3500

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............ Fort Stewart, GA 31314-5000
Phone.................................. (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample................. BW From Boiler 4

Pretreatment.. Resin

Feedwater Temp (F)............................... 212
Feedwater Deoxygenation Method(s):
Mechanical...
Oxygen Scavenger.................... Sodium Sulfite

Boiler Type.................................. Water Tube
Steam Gauge Pressure (PSIG)......................... 220
Boiler Horsepower......................................
Boiler Output (PPH)............................ 23,000
Boiler Treatment:
pH Control...
Phosphate.................sodium hexametaphosphate
Dispersant...

Condensate pH Control.........................morpholine

Comments

2P-M = 3

2P-M = OH

- F.D.

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement is good overall noting only a minor discrepancy for phosphate . Sulfite difference is normal since sulfite will degrade over time.

2. Results show that phosphate is below the control range. Sulfite is signficantly overdosed while causticity is within range. Blowdown is excessive based on low TDS.

continued...

RECOMMENDATIONS:

1. Reduce blowdown to allow TDS to rise into range. This can include bottom blowdown when boiler loads are light. Treatment levels will rise proportional to the rise in TDS when chemicals are fed at a constant rate so feedrates may need adjustment to keep chemical levels within their control ranges.

2. If phosphate level does not come up sufficiently by reducing blowdown, increase the phosphate dosage.

3. Reduce sulfite dosage to allow level to drop into range.

REPORT PREPARED BY: J. Tiangco

BOILER SYSTEM WATER ANALYSIS PROGRAM

FORT STEWART BLDG 1412 HIGH TEMP SYSTEM

Sample Number . . . . XFSTEWHT
Date Sampled 07/18/95
Date Received 08/14/95
Date Analyzed 08/17/95
Date Report Issued . 08/25/95

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............. Fort Stewart, GA 31314-5000
Phone................................ (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample......... Water From Cascade Heater

System Type.......................... Hot Water Boiler
Steam Gauge Pressure (PSIG).........................
Boiler Horsepower...................................
Boiler Output (BTU/HR)...............................

Hot Water Temp (F)..................................
Hot Water pH Control................................
Oxygen Scavenger........................ Sodium Sulfite

Comments

High Temperature Water Analysis Report

Test Description	P&A	Plant	Control
Specific Sx Description			
Total Hardness, ppm $CaCO_3$	<1		<2
Total Iron, ppm Fe	<0.05		
pH	9.2	9.9	9.3 - 9.9
Sulfite, ppm Na_2SO_3	<2	30	0 - 40
As Rcvd Cond, mmhos	220	0-200	

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement for pH is good. It is not clear what the plant means in reporting conductivity and TDS as 0-200. Sulfite difference is normal since sulfite will degrade over time.

2. Results shows only a trace of iron indicating good mild steel corrosion protection. The pH is within the control range.

RECOMMENDATIONS:

1. Please explain your rationale for reporting conductivity/TDS as 0-200. Other than that, no changes recommended at this time.

REPORT PREPARED BY: J. Tiangco & D.J. Robinette

Puckorius & Associates. Inc. P.O. Box 2440. Evergreen. CO 80439 303-674-9897

BOILER SYSTEM WATER ANALYSIS PROGRAM

FORT STEWART BLDG 1412 HIGH TEMP SYSTEM

Sample Number . . . . XFSTEWHT
Date Sampled 07/18/95
Date Received 08/14/95
Date Analyzed 08/17/95
Date Report Issued . 08/25/95

High Temperature Water Analysis Report

Test Description	P&A	Plant	Control
Specific Sx Description			
Total Hardness, ppm $CaCO_3$	<1		<2
Total Iron, ppm Fe	<0.05		
pH	9.2	8.9	9.3 - 9.9
Sulfite, ppm Na_2SO_3	<2	30	0 - 40
As Rcvd Cond, mmhos	220	0-200	

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip............. Fort Stewart, GA 31314-5000
Phone................................. (912) 767-8931

Building Sample is From........... Central Energy Plant
Description of Sample......... Water From Cascade Heater

System Type........................... Hot Water Boiler
Steam Gauge Pressure (PSIG)............................
Boiler Horsepower...................................
Boiler Output (BTU/HR)...............................

Hot Water Temp (F)...................................
Hot Water pH Control.................................
Oxygen Scavenger........................ Sodium Sulfite

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement for pH is good. It is not clear what the plant means in reporting conductivity and TDS as 0-200. Sulfite difference is normal since sulfite will degrade over time.

2. Results shows only a trace of iron indicating good mild steel corrosion protection. The pH is within the control range.

RECOMMENDATIONS:

1. Please explain your rationale for reporting conductivity/TDS as 0-200. Other than that, no changes recommended at this time.

REPORT PREPARED BY: J. Tiangco & D.J. Robinette

Puckorius & Associates, Inc. P.O. Box 2440, Evergreen, CO 80439 303-674-9897

BOILER SYSTEM WATER ANALYSIS PROGRAM

FORT STEWART BUILDING 1412 MAKEUP WATER

Sample Number . . . . xestewmu
Date Sampled 07/18/95
Date Received 08/14/95
Date Analyzed 08/17/95
Date Report Issued . 08/25/95

Makeup /Water Analysis Report

Test Description	P&A	Plant	Control
Specific Sx Description	Sample not full. Clear.		
Total Hardness, ppm $CaCO_3$	<1	0-2	<2
As Rcvd Cond, mmhos	245	150	
Total Diss Solids, ppm	170	105	
Total Iron, ppm Fe	0.1		
pH	7.3		
M Alkalinity, ppm $CaCO_3$	121		

Specific Installation Information

Post.................................... Fort Stewart
City/State/Zip.................. Fort Stewart, GA 31314
Phone................................ ( ) 767-8931

Building Sample Is From........... Central Energy Plant-
Description Of Sample.................... Make-up water

Pretreatment...

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. Test agreement for conductivity/TDS is poor. Hardness results agree well.
2. Results show a sample that is soft and low in iron - a good quality makeup water. The M-alkalinity is naturally high and a dealkalizer would probably allow operations to run higher cycles of concentration. The payback would be reduced energy, water, and chemical consumption.

RECOMMENDATIONS:

1. Calibrate your conductivity meter and make sure that the sample cup has been thoroughly flushed before taking a reading. No other changes recommended at this time.

REPORT PREPARED BY: J. Tiangco

Puckorius & Associates, Inc. P.O. Box 2440, Evergreen, CO 80439 303-674-9897

BOILER SYSTEM WATER ANALYSIS PROGRAM
FORT STEWART BUILDING 1412 CONDENSATE

Sample Number . . . . XDSTEWCN
Date Sampled 07/18/95
Date Received 08/14/95
Date Analyzed 08/17/95
Date Report Issued . 08/25/95

Condensate Water Analysis Report

Test Description	P&A	Plant	Control
Specific Sx Description	Sample not full. Clear.		
Total Hardness, ppm $CaCO_3$	<2	0-2	<2
As Rcvd Cond, mmhos	42	0-100	<35
Total Diss Solids, ppm	29	0-100	
Total Iron, ppm Fe	0.1		
pH	8.7	8.7	7.5 - 8.8
M Alkalinity, ppm $CaCO_3$	69		
Carbon Dioxide, ppm CO_2	<1		

Specific Installation Information

Post................................ Fort Stewart
City/State/Zip............. Fort Stewart, GA 31314
Phone............................ ( ) 767-8931

Building Sample is From....... Central Energy Plant
Description of Sample.................. Condensate

Condensate pH Control.................. Morpholine

Comments

NOTE: REMARKS AND RECOMMENDATIONS REFLECT CONDITIONS AT TIME OF SAMPLING AND MAY NOT APPLY TO CURRENT CONDITIONS.

REMARKS:

1. It is not clear what the plant is trying to report for conductivity/TDS using "0-100". Test agreement for pH is good however.
2. Results show that the sample exceeds conductivity purity criteria however the iron level is acceptably low and the pH is within the control range.

RECOMMENDATIONS:

1. The small amount of contamination evidenced in the conductivity could be due to sampling error. Make sure that sample containers and sample lines are thoroughly flushed out before drawing a sample. If conductivity remains high, further troubleshooting should be undertaken.
2. No changes necessary for pH control.

REPORT PREPARED BY: J. Tiangco & D.J. Robinette

ANALYSIS OF DHW SAMPLES

Fort Stewart Hot Water Generators
Water Analysis Data – Number of SD Above or Below AVG
Filename: WATRANAL.WQ1

Bldg	°F	#SD	Cond	#SD	pH	#SD	PO4	#SD	SO4	#SD	Fe	#SD	#SD≥1	PREMIER	RANK
AVG	131		252		7.80		0.19		5		0.03				
SD	21.3		16.5		0.17		0.08		3.5		0.04				
206	80	0.0	250	0.1	8.10	1.8	0.13	0.0	2	0.0	0.27	6.1	2		
207	124	0.0	236	1.0	7.80	0.0	0.22	0.3	2	0.0	0.09	1.6	2		
208	113	0.0	238	0.9	8.15	2.1	0.19	0.0	1	0.0	0.03	0.1	1		
212	131	0.0	227	1.5	8.10	1.8	0.21	0.2	–	0.0	0.02	0.0	2		
213	120	0.0	229	1.4	7.75	0.0	0.13	0.0	–	0.0	0.01	0.0	1		
215	137	0.3	227	1.5	7.80	0.0	0.13	0.0	–	0.0	0.04	0.4	1		
216	110	0.0	227	1.5	7.85	0.3	0.07	0.0	–	0.0	--	0.0	1		
218	124	0.0	236	1.0	7.80	0.0	0.12	0.0	–	0.0	0.01	0.0	1		
302	137	0.3	237	0.9	7.65	0.0	0.14	0.0	–	0.0	0.02	0.0	0		
439	139	0.4	246	0.4	7.75	0.0	0.12	0.0	7	0.6	0.02	0.0	0	✓	
440	114	0.0	243	0.6	7.95	0.9	0.17	0.0	9	1.1	0.02	0.0	1	✓	
501	134	0.2	243	0.6	7.85	0.3	0.18	0.0	12	2.0	0.03	0.1	1	✓	
503	122	0.0	243	0.6	8.00	1.2	0.17	0.0	13	2.3	0.03	0.1	2	✓	
504	158	1.3	239	0.8	8.05	1.5	0.14	0.0	10	1.4	0.01	0.0	3	✓	
512	145	0.7	242	0.6	7.55	0.0	0.16	0.0	11	1.7	0.01	0.0	1	✓	
514	126	0.0	244	0.5	7.85	0.3	0.18	0.0	9	1.1	0.02	0.0	1	✓	
515	123	0.0	236	1.0	7.70	0.0	0.18	0.0	1	0.0	0.02	0.0	1		
516	145	0.7	242	0.6	7.70	0.0	0.29	1.2	5	0.0	--	0.0	1	✓	OVERFLOW
517	175	2.1	244	0.5	7.70	0.0	0.28	1.1	8	0.9	--	0.0	2	✓	
518	183	2.5	234	1.1	7.70	0.0	0.36	2.1	9	1.1	--	0.0	4	✓	
608	127	0.0	240	0.7	7.60	0.0	0.31	1.5	11	1.7	0.01	0.0	2	✓	
610	115	0.0	230	1.3	7.75	0.0	0.18	0.0	7	0.6	0.12	2.3	2	✓	
620	112	0.0	240	0.7	7.75	0.0	0.17	0.0	3	0.0	--	0.0	0		
621	91	0.0	244	0.5	7.85	0.3	0.16	0.0	3	0.0	0.02	0.0	0		
622	85	0.0	244	0.5	7.60	0.0	0.05	0.0	2	0.0	0.02	0.0	0		
623	109	0.0	238	0.9	7.65	0.0	0.09	0.0	5	0.0	--	0.0	0		
624	84	0.0	237	0.9	7.55	0.0	0.05	0.0	–	0.0	--	0.0	0		
626	145	0.7	275	0.0	7.45	0.0	0.08	0.0	7	0.6	--	0.0	0		
629	160	1.4	263	0.0	7.85	0.3	0.08	0.0	5	0.0	--	0.0	1		
630	117	0.0	272	0.0	7.90	0.6	0.22	0.3	6	0.3	0.02	0.0	0	✓	
631	142	0.5	267	0.0	7.75	0.0	0.15	0.0	6	0.3	0.02	0.0	0		
632	160	1.4	268	0.0	7.65	0.0	0.19	0.0	6	0.3	--	0.0	1		
633	128	0.0	272	0.0	7.60	0.0	0.13	0.0	–	0.0	--	0.0	0		
635	140	0.4	274	0.0	8.25	2.6	0.16	0.0	–	0.0	--	0.0	1		
636	138	0.3	280	0.0	7.75	0.0	0.19	0.0	–	0.0	--	0.0	0		
637	158	1.3	278	0.0	7.75	0.0	0.23	0.5	–	0.0	--	0.0	1		
642	154	1.1	278	0.0	7.70	0.0	0.29	1.2	10	1.4	--	0.0	3	✓	
701	152	1.0	272	0.0	7.75	0.0	0.12	0.0	7	0.6	--	0.0	1	✓	
702	143	0.6	277	0.0	7.85	0.3	0.10	0.0	9	1.1	--	0.0	1	✓	
708	131	0.0	265	0.0	7.70	0.0	0.10	0.0	6	0.3	--	0.0	0		
712	135	0.2	279	0.0	7.65	0.0	0.22	0.3	9	1.1	--	0.0	1	✓	
713	133	0.1	271	0.0	7.70	0.0	0.27	1.0	8	0.9	0.03	0.1	1	✓	
714	137	0.3	267	0.0	7.70	0.0	0.27	1.0	7	0.6	0.01	0.0	1	✓	
715	135	0.2	263	0.0	7.80	0.0	0.36	2.1	5	0.0	--	0.0	1	✓	
717	131	0.0	263	0.0	7.75	0.0	0.26	0.8	4	0.0	--	0.0	0		
718	124	0.0	260	0.0	7.65	0.0	0.33	1.7	2	0.0	--	0.0	1		
719	112	0.0	265	0.0	7.85	0.3	0.21	0.2	2	0.0	--	0.0	0		
720	130	0.0	281	0.0	8.25	2.6	0.29	1.2	7	0.6	0.03	0.1	2	✓	
726	158	1.3	254	0.0	8.05	1.5	0.33	1.7	7	0.6	0.06	0.9	3	✓	
810	131	0.0	248	0.3	7.90	0.6	0.27	1.0	2	0.0	0.01	0.0	1		
1540	95	0.0	248	0.3	7.95	0.9	0.27	1.0	2	0.0	0.09	1.6	2		
1720	148	0.8	248	0.3	7.75	0.0	0.22	0.3	5	0.0	0.02	0.0	0		
2125	120	0.0	245	0.4	7.85	0.3	0.30	1.3	–	0.0	0.02	0.0	1		

T.M.

PREMIER WATER & ENERGY TECHNOLOGY, INC.

		Reynolds, Smith & Hills, Inc.					
		Potable Hot Water - Ft. Stewart, Ga.					
	Sample						
Location	Date	Conductivity	pH	PO4	SO4	Fe	
HTHW	10/4/95	185	9.05	2.65	20	0.09	
206	10/4/95	250	8.10	0.13	2	0.27	
207	10/4/95	236	7.80	0.22	2	0.09	
208	10/4/95	238	8.15	0.19	1	0.03	
212	10/4/95	227	8.10	0.21	<1	0.02	
213	10/4/95	229	7.75	0.13	<1	0.01	
215	10/4/95	227	7.80	0.13	<1	0.04	
216	10/4/95	227	7.85	0.07	<1	<.01	
218	10/4/95	236	7.80	0.12	<1	0.01	
302	10/4/95	237	7.65	0.14	<1	0.02	
439	10/3/95	246	7.75	0.12	7	0.02	*
440	10/3/95	243	7.95	0.17	9	0.02	*
501	10/3/95	243	7.85	0.18	12	0.03	*
503	10/3/95	243	8.00	0.17	13	0.03	*
504	10/3/95	239	8.05	0.14	10	0.01	*
512	10/3/95	242	7.55	0.16	11	0.01	*
514	10/2/95	244	7.85	0.18	9	0.02	*
515	10/2/95	236	7.70	0.18	1	0.02	
516	10/2/95	242	7.70	0.29	5	<.01	*
517	10/2/95	244	7.70	0.28	8	<.01	*
518	10/2/95	234	7.70	0.36	9	<.01	*
608	10/3/95	240	7.60	0.31	11	0.01	*
610	10/4/95	230	7.75	0.18	7	0.12	*
620	10/3/95	240	7.75	0.17	3	<.01	
621	10/3/95	244	7.85	0.16	3	0.02	
622	10/3/95	244	7.60	0.05	2	0.02	
623	10/3/95	238	7.65	0.09	5	<.01	
624	10/3/95	237	7.55	0.05	<1	<.01	
626	10/3/95	275	7.45	0.08	7	<.01	
629	10/3/95	263	7.85	0.08	5	<.01	
630	10/3/95	272	7.90	0.22	6	0.02	*
631	10/3/95	267	7.75	0.15	6	0.02	
632	10/3/95	268	7.65	0.19	6	<.01	
633	10/3/95	272	7.60	0.13	<1	<.01	
635	10/3/95	274	8.25	0.16	<1	<.01	

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PREMIER WATER & ENERGY TECHNOLOGY, INC.

		Reynolds, Smith & Hills, Inc.					
		Potable Hot Water - Ft. Stewart, Ga.					
Location	Sample Date	Conductivity	pH	PO4	SO4	Fe	
636	10/3/95	280	7.75	0.19	<1	<.01	
637	10/3/95	278	7.75	0.23	<1	<.01	
642	10/3/95	278	7.70	0.29	10	<.01	*
701	10/3/95	272	7.75	0.12	7	<.01	*
702	10/3/95	277	7.85	0.10	9	<.01	*
708	10/3/95	265	7.70	0.10	6	<.01	
712	10/3/95	279	7.65	0.22	9	<.01	*
713	10/3/95	271	7.70	0.27	8	0.03	*
714	10/3/95	267	7.70	0.27	7	0.01	*
715	10/3/95	263	7.80	0.36	5	<.01	*
717	10/3/95	263	7.75	0.26	4	<.01	
718	10/3/95	260	7.65	0.33	2	<.01	
719	10/3/95	265	7.85	0.21	2	<.01	
720	10/3/95	281	8.25	0.29	7	0.03	*
726	10/3/95	254	8.05	0.33	7	0.06	*
810	10/3/95	248	7.90	0.27	2	0.01	
1540	10/3/95	248	7.95	0.27	2	0.09	
1720	10/3/95	248	7.75	0.22	5	0.02	
2125	10/3/95	245	7.85	0.30	<1	0.02	
2125 P	10/3/95	241	7.85	0.04	<1	0.01	

PO4 = Phosphate
SO4 = Sulfate
Fe = Iron

The samples that are marked in the far right column with an asterisk indicate sufficient differences in readings to suspect the possibility of leakage in these units.

11481 Columbia Park Drive West • Jacksonville, Florida 32258-2478 • (904) 268-1152 • Fax (904) 268-6851 • (800) 741-0984

Fort Stewart Hot Water Generators
Water Analysis Data – Sorted by Component & Ranked
Filename: WATRANAL.WQ1

Bldg	°F	Rk	Bldg	Cond	Rk	Bldg	pH	Rk	Bldg	PO4	Rk	Bldg	SO4	Rk	Bldg	Fe	Rk
518	183	1	212	227	1	635	8.25	1	715	0.36	1	503	13	1	206	0.27	1
517	175	2	215	227	1	720	8.25	1	518	0.36	1	501	12	2	610	0.12	2
629	160	3	216	227	1	208	8.15	2	718	0.33	2	608	11	3	1540	0.09	3
632	160	3	213	229	2	206	8.10	3	726	0.33	2	512	11	3	207	0.09	3
504	158	4	610	230	3	212	8.10	3	608	0.31	3	504	10	4	726	0.06	4
637	158	4	518	234	4	726	8.05	4	2125	0.30	4	642	10	4	215	0.04	5
726	158	4	218	236	5	504	8.05	4	642	0.29	5	702	9	5	720	0.03	6
642	154	5	207	236	5	503	8.00	5	720	0.29	5	440	9	5	208	0.03	6
701	152	6	515	236	5	440	7.95	6	516	0.29	5	518	9	5	501	0.03	6
1720	148	7	624	237	6	1540	7.95	6	517	0.28	6	514	9	5	713	0.03	6
512	145	8	302	237	6	810	7.90	7	1540	0.27	7	712	9	5	503	0.03	6
516	145	8	623	238	7	630	7.90	7	810	0.27	7	713	8	6	515	0.02	7
626	145	8	208	238	7	621	7.85	8	713	0.27	7	517	8	6	1720	0.02	7
702	143	9	504	239	8	719	7.85	8	714	0.27	7	626	7	7	621	0.02	7
631	142	10	620	240	9	629	7.85	8	717	0.26	8	610	7	7	622	0.02	7
635	140	11	608	240	9	702	7.85	8	637	0.23	9	714	7	7	514	0.02	7
439	139	12	516	242	10	216	7.85	8	1720	0.22	10	720	7	7	302	0.02	7
636	138	13	512	242	10	514	7.85	8	207	0.22	10	439	7	7	2125	0.02	7
215	137	14	440	243	11	2125	7.85	8	630	0.22	10	726	7	7	212	0.02	7
302	137	14	503	243	11	501	7.85	8	712	0.22	10	701	7	7	439	0.02	7
714	137	14	501	243	11	207	7.80	9	212	0.21	11	631	6	8	631	0.02	7
712	135	15	622	244	12	715	7.80	9	719	0.21	11	708	6	8	630	0.02	7
715	135	15	621	244	12	215	7.80	9	208	0.19	12	630	6	8	440	0.02	7
501	134	16	514	244	12	218	7.80	9	636	0.19	12	632	6	8	714	0.01	8
713	133	17	517	244	12	636	7.75	10	632	0.19	12	629	5	9	504	0.01	8
212	131	18	2125	245	13	717	7.75	10	514	0.18	13	623	5	9	512	0.01	8
708	131	18	439	246	14	631	7.75	10	501	0.18	13	516	5	9	213	0.01	8
717	131	18	1540	248	15	701	7.75	10	515	0.18	13	1720	5	9	218	0.01	8
810	131	18	810	248	15	213	7.75	10	610	0.18	13	715	5	9	810	0.01	8
720	130	19	1720	248	15	637	7.75	10	440	0.17	14	717	4	10	608	0.01	8
633	128	20	206	250	16	1720	7.75	10	620	0.17	14	621	3	11	712	--	9
608	127	21	726	254	17	439	7.75	10	503	0.17	14	620	3	11	708	--	9
514	126	22	718	260	18	620	7.75	10	635	0.16	15	207	2	12	702	--	9
207	124	23	717	263	19	610	7.75	10	621	0.16	15	1540	2	12	717	--	9
218	124	23	715	263	19	714	7.70	11	512	0.16	15	810	2	12	719	--	9
718	124	23	629	263	19	713	7.70	11	631	0.15	16	206	2	12	715	--	9
515	123	24	708	265	20	708	7.70	11	302	0.14	17	622	2	12	718	--	9
503	122	25	719	265	20	515	7.70	11	504	0.14	17	718	2	12	701	--	9
213	120	26	631	267	21	517	7.70	11	215	0.13	18	719	2	12	620	--	9
2125	120	26	714	267	21	518	7.70	11	213	0.13	18	515	1	13	623	--	9
630	117	27	632	268	22	642	7.70	11	633	0.13	18	208	1	13	624	--	9
610	115	28	713	271	23	516	7.70	11	206	0.13	18	2125	-	14	518	--	9
440	114	29	633	272	24	718	7.65	12	218	0.12	19	216	-	14	216	--	9
208	113	30	630	272	24	302	7.65	12	439	0.12	19	218	-	14	516	--	9
620	112	31	701	272	24	623	7.65	12	701	0.12	19	215	-	14	517	--	9
719	112	31	635	274	25	712	7.65	12	702	0.10	20	212	-	14	626	--	9
216	110	32	626	275	26	632	7.65	12	708	0.10	20	213	-	14	636	--	9
623	109	33	702	277	27	608	7.60	13	623	0.09	21	302	-	14	637	--	9
1540	95	34	642	278	28	622	7.60	13	626	0.08	22	636	-	14	642	--	9
621	91	35	637	278	28	633	7.60	13	629	0.08	22	637	-	14	635	--	9
622	85	36	712	279	29	512	7.55	14	216	0.07	23	635	-	14	629	--	9
624	84	37	636	280	30	624	7.55	14	622	0.05	24	624	-	14	632	--	9
206	80	38	720	281	31	626	7.45	15	624	0.05	24	633	-	14	633	--	9

Fort Stewart Hot Water Generators
Water Analysis Data - Sorted by Bldg Number
Filename: WATRANAL.WQ1

Bldg	°F	Cond	pH	P04	S04	Fe
PW		241	7.85	0.04	1	0.01
HTHW		185	9.05	2.65	20	0.09
BLDG	°F	COND	PH	P04	S04	FE
206	80	250	8.10	0.13	2	0.27
207	124	236	7.80	0.22	2	0.09
208	113	238	8.15	0.19	1	0.03
212	131	227	8.10	0.21	1	0.02
213	120	229	7.75	0.13	1	0.01
215	137	227	7.80	0.13	1	0.04
216	110	227	7.85	0.07	1	0.01
218	124	236	7.80	0.12	1	0.01
302	137	237	7.65	0.14	1	0.02
439	139	246	7.75	0.12	7	0.02
440	114	243	7.95	0.17	9	0.02
501	134	243	7.85	0.18	12	0.03
503	122	243	8.00	0.17	13	0.03
504	158	239	8.05	0.14	10	0.01
512	145	242	7.55	0.16	11	0.01
514	126	244	7.85	0.18	9	0.02
515	123	236	7.70	0.18	1	0.02
516	145	242	7.70	0.29	5	0.01
517	175	244	7.70	0.28	8	0.01
518	183	234	7.70	0.36	9	0.01
608	127	240	7.60	0.31	11	0.01
610	115	230	7.75	0.18	7	0.12
620	112	240	7.75	0.17	3	0.01
621	91	244	7.85	0.16	3	0.02
622	85	244	7.60	0.05	2	0.02
623	109	238	7.65	0.09	5	0.01
624	84	237	7.55	0.05	1	0.01
626	145	275	7.45	0.08	7	0.01
629	160	263	7.85	0.08	5	0.01
630	117	272	7.90	0.22	6	0.02
631	142	267	7.75	0.15	6	0.02
632	160	268	7.65	0.19	6	0.01
633	128	272	7.60	0.13	1	0.01
635	140	274	8.25	0.16	1	0.01
636	138	280	7.75	0.19	1	0.01
637	158	278	7.75	0.23	1	0.01
642	154	278	7.70	0.29	10	0.01
701	152	272	7.75	0.12	7	0.01
702	143	277	7.85	0.10	9	0.01
708	131	265	7.70	0.10	6	0.01
712	135	279	7.65	0.22	9	0.01
713	133	271	7.70	0.27	8	0.03
714	137	267	7.70	0.27	7	0.01
715	135	263	7.80	0.36	5	0.01
717	131	263	7.75	0.26	4	0.01

718	124	260	7.65	0.33	2	0.01
719	112	265	7.85	0.21	2	0.01
720	130	281	8.25	0.29	7	0.03
726	158	254	8.05	0.33	7	0.06
810	131	248	7.90	0.27	2	0.01
1540	95	248	7.95	0.27	2	0.09
1720	148	248	7.75	0.22	5	0.02
2125	120	245	7.85	0.30	1	0.02

	°F	COND	PH	PO4	SO4	FE
MIN	80.0	227.0	7.5	0.05	1.0	0.01
AVG	130.6	252.2	7.8	0.19	5.0	0.03
MAX	183.0	281.0	8.3	0.36	13.0	0.27
P-SD	21.3	16.5	0.17	0.08	3.5	0.04
P-VAR	454	273	0.03	0.01	12	0.002
AVG ± SD	151.9	235.7	8.0	0.27	8.5	0.07

RS&H

Telephone Call Confirmation

268-1152

Project Number 694-1331-002

Local ______ L.D. ______ Placed ______ Rec'd ______ Date 9-18-95

Conversed with Gale Fillinger Of Premier Water and Energy Tech.

Regarding Fort Stewart HTW Analysis

Gale is familiar with the HTW treatment at Fort Stewart. He thinks they could detect differences in phosphate, conductivity and ph if the heat exchangers were leaking. We should also take 3-5 samples of potable water from different areas of the Fort, and two samples of the HTW. Samples from barracks should be taken in the afternoon. Cost of analysis is about $25 each and it will take 2-3 days to do 100+ samples and prepare a report. They will provide the sample bottles (~1 pint each) with lablels we can mark on. He would like about 1 week notice prior to the site visit to make sure they have enough sample bottles on-hand. Their facility is located near Sherrod Vans off Greenland Road.

Distribution:

RS&H

Telephone Call Confirmation

Project Number 694-1331-002

Local ______ L.D. ______ Placed ______ Rec'd ______ Date 9-14-95

Conversed with Tom Brandvold Of Premier Water & Energy Tech.
268-1152

Regarding Fort Stewart Water Analysis

Premier currently treats and tests the condenser water for the CEP at Fort Stewart. Tom thinks they could detect HTW in the domestic hot water by lab analysis. Gale Fillinger has the account for Fort Stewart.

Tom will meet with Gale and try to figure out the best method to accomplish our task and they will call me back next week.

Distribution:

A.7 SUBMITTAL REVIEW COMMENTS AND REVIEW ACTIONS

INTERIM

PROJECT REVIEW COMMENTS		Date: 12 APR 96	Page 1 of 1
TO: MR. CHET SCRATZMEIER CHIEF, PROJ/PROJ MGMT & OPS DIVISION	FROM: (Section) DPW, EP&S DIVISION (Reviewer) POWELL		
Project: LIMITED ENERGY STUDY, HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS Location: FORT STEWART AND HUNTER AAF, GA	Year: FY-96	Line Item No. DACA01-94-D-0038 #694-1331-002	

Type of Action (Check Appropriate Boxes): [ ] Preliminary [ ] Final [X] INTERIM [ ] Paving & Grading [ ] Architectural [ ] Structural [X] Mechanical [ ] Electrical [ ] Sanitary

Item No.	Drawing No. or Paragraph No	COMMENTS	REVIEW ACTION
1.	GENERAL	RECOMMEND THAT THE PRE-FINAL REPORT CONTAIN A DISCUSSION AND RECOMMENDATIONS ON WATER TREATMENT AND CATHODIC PROTECTION, SACRIFICIAL ANODE, OR OTHER CORROSION AND SCALE PREVENTION/PROTECTION PRACTICES THAT COULD BE IMPLEMENTED OR THAT NEED CHANGING AT FT. STEWART AND HUNTER AAF TO INCREASE THE LIFE OF THE DISTR. SYSTEMS.	CONCUR. DISCUSSION OF CURRENT PRACTICES AND CATHODIC PROTECTION WERE ADDED TO SECTION 4.3.
2.	VOLUME 1 PARA. 5.2 / 1 C.E.P.	THE RECOMMENDATION SHOULD ADDRESS ANY NEGATIVE EFFECTS OR REDUCTION IN PLANT CAPABILITY BY REDUCING THE SYSTEM PRESSURE AS RECOMMENDED.	CONCUR. DISCUSSION WAS ADDED TO THE ECO-12 RECOMMENDATIONS.
3.	VOLUME 1 PARA. 5.2 C.E.P.	PREVIOUS STUDIES HAVE MENTIONED DEAERATOR PROBLEMS THAT COULD CAUSE CORROSION TO ACCELERATE IN THE HTHW DISTRIBUTION SYSTEM. THIS SHOULD BE INVESTIGATED TO DETERMINE IF THE PROBLEMS HAVE BEEN CORRECTED, AND IF NOT, RECOMMENDATIONS SHOULD BE ADDED TO THE PRE-FINAL REPORT.	NO ACTION REQUIRED. THE DEAERATOR PROBLEMS HAVE BEEN CORRECTED.
4.	VOLUME 1 PARA. 5.2 VALVE PITS	TREES AND SHRUBS HAVE BEEN OBSERVED GROWING IN VALVE PITS IN THE PAST. REMOVAL OF THIS DESTRUCTIVE GROWTH AT AN EARLY STAGE, TO PREVENT DAMAGE TO THE PITS AND PIPING SHOULD BE INCLUDED IN THE FINAL O&M RECOMMENDATIONS.	CONCUR. COMMENT AND LOCATION OF VALVE PIT WILL BE ADDED TO THE O&M RECOMMEND.
5.	VOLUME 3 SURVEY FORMS	RECOMMEND THAT A COPY OF THESE FIELD NOTES BE GIVEN TO THE MECHANICAL SHOPS. A LOT OF LEG WORK HAS BEEN DONE IN THIS INVESTIGATION, AND THE MECHANICAL ROOMS WITH THE LARGEST LEAKS ARE IDENTIFIED AND CAN BE REPAIRED.	CONCUR, A SUMMARY OF THE VALVE PIT SURVEY AND MECH. EQUIPMENT ROOM SURVEY WILL BE ADDED TO VOLUME 3.

AFZP FORM 193

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Response to Review Comments

Date: May 28, 1996

Reviewer: Chet Scratzmeier (by Powell)
Fort Stewart DPW, EP&S Division

Response by: William T. Todd, PE

Subject: Interim Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

Number	Dwg/Pg/Par.	Response	Review Action Comments
1	General	Concur	A discussion of cathodic protection and current water treatment practices will be added as Section 4.3.
2	Vol. 1, Par 5.2	Concur	A discussion of operation at reduced pressures will be added to the ECO-12 Recommendations in Section 4.4.
3	Vol. 1, Par 5.2	Concur	No action required. The problems with the deaerator have been corrected.
4	Vol. 1, Par 5.2	Concur	An O&M recommendation with the valve pit number and location will be added to Section 5.2.
5	Vol. 3, Forms	Concur	A summary of findings for the valve pit survey and the mechanical equipment room survey will be added to Appendix Sections B.1 and B.2, respectively.

CC: C. Warren
File

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CESAS-EN-DM Date: 15 APR 1996 INTERIM

MEMORANDUM THRU EN-D/DESIGN BRANCH

FOR EN-PM

SUBJECT: HTW/CHW DISTR STUDY, FY-96, LI 6029000, FORT STEWART, GA,.

1.		Enclosed are this sections A/E specific instructions with manday estimate.
2.		a. Man-day estimate (mandatory for all change orders) is: [ ] Professional [ ] Sub-professional [ ] Clerical *b. Number of sheets of new drawings:*
3.		*The A/E's specifications have been reviewed and* [ ] are satisfactory subject to enclosed comments [ ] A/E should visit the District office for special instruction prior to preparation of specifications.
4.		*Revised A/E instructions are enclosed.*
5.	X	*The A/E's* [ ] Concept submittal [ ] % preliminary Corrected [ ] Final submittal [XX] Study [ ] Cost Estimate [ ] FP Eng Credentials [ ] is approved for continuation of design subject to enclosed comments. [ ] shall be revised in accordance with enclosed comments & *RESUBMITTED* prior to preceding with design. SECTION CHIEF: ________ [XX] is satisfactory. CONCUR. NO ACTION REQUIRED. [ ] shall be revised in accordance with enclosed comments.
6.		*The design of the project thus far* [ ] is [ ] is not *satisfactory for A/E payment.*
7.		*The enclosed annotated review comments have been reviewed and* [ ] the annotation added by the A/E are satisfactory [ ] the annotations are satisfactory except as indicated by the enclosed additional comments.
8.		*The comments prepared by* *are appropriate for mailing to the A/E.*
9.		*The comments prepared by* *are appropriate except where indicated. Additional comments or clarifications are enclosed.*
10.		*The enclosed meeting notification is acknowledged.* [ ] No one from this section will attend. [ ] The following team member will attend ________
11.		*This project's Arms Room design* [ ] is satisfactory [ ] does not have an Arms Rm or Vault.
12.	X	*EXCELLENT SUBMITTAL* CONCUR. NO ACTION REQUIRED.

Prepared by: WALT HOHNE

SAS FL 207 (April 89)

INTERIM

MOBILE DISTRICT PROJECT REVIEW COMMENTS:	DATE: April 10, 1996	Page 1 of 1
TO: U. S. Army Corps of Engineers Savannah District Savannah, GA.	FROM: Robert S. Woodruff, CESAM-EN-DM Phone: (334) 694-6074 FAX: (334) 690-2424	

PROJECT/FY: Limited Energy Study High Temperature and Chilled Water Distribution Systems

LOCATION: Fort Stewart and Hunter AAF, GA.

TYPE REVIEW: Interim Submittal

NO.	Page/Par	COMMENT	Response to Comment
1.	P. 1-1	The conclusions of the previous report which eliminated the High Temperature water system at Hunter AAF and both chilled water systems from this study should be restated here. As presented the reader is left wondering what happened to that part of the study because Appendix A.10 does not exist in this report.	CONCUR. APPENDIX A.10 WILL BE INC. IN THE PRE-FINAL SUBMITTAL.
2.	P. 1-2	The evaluation of E.C.O. 8 (Repair underground HTW system leaks) is dependent on the completion of the underground piping leak survey. The corroborating evidence that 40 % of the system leaks are in the underground piping is dependent on the completion of the underground piping leak survey. The Scope of Work (Para. 6.1) requires that all ECO's be evaluated in the interim report. Because of the importance of this survey and the resulting work related to it the interim report can not be considered complete without it. The A/E should resubmit the interim report when this work is completed.	CONCUR. COPY WAS PROVIDED AT THE REVIEW MEETING. RESUBMITTAL IS NOT REQUIRED. ECO 8 WILL BE INCLUDED IN PRE-FINAL RPT.
3.	P. 4-11 Para. 5	This paragraph states that 40% of the high temperature water system leak losses are in the underground portion of the piping. If 40% of the losses were caused by one or two leaks wouldn't they be worth repairing ?	CONCUR. THIS WAS ADDRESSED BY ECO 8 WILL CLARIFY TEXT IN PREFINAL REPORT.
4.	P. 4-36 Para. 4	Is there any basis for concluding that half of the underground piping insulation is deteriorated ?	CONCUR. Basis for THIS VALUE WILL BE ADDED TO TEXT.

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Response to Review Comments

Date: May 28, 1996

Reviewer: Robert S. Woodruff, CESAM-EN-DM
U. S. Army COE, Savannah District

Response by: William T. Todd, PE

Subject: Interim Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

Number	Dwg/Pg/Par.	Response	Review Action Comments
1	Pg 1-1	Concur	Appendix A.10 will be included in the Pre-final Submittal.
2	Pg 1-2	Concur	Resubmittal is not required. A copy of the ECO-8 evaluation and recommendations was provided at the review meeting and will be included in the Pre-final submittal.
3	Pg 4-11, Par 5	Concur	The analysis for ECO-8 indicates there are many small leaks. The text in the Pre-final submittal will be modified to clearly indicate the number and quantity of leaks.
4	Pg 4-36, Par 4	Concur	The assumption was based on our field observations of the valve pits and conduit vents. This will be added to the text.

CC: C. Warren
File

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INTERIM

CECPW-EM 11 April 1996

MEMORANDUM FOR Commander, U.S. Army Forces Command,
ATTN: AFPI-ENO (Mr. Naresh Kapur)
Fort McPherson, GA 30330-6000

SUBJECT: Review of Interim Report on Fort Stewart's High Temperature and Chilled Water Distribution System

1. Reference 1 April 1996 phone call from Naresh Kapur, FORSCOM, to Dennis Vevang, CECPW-EM, requesting review of Fort Stewart's interim report. NO ACTION REQUIRED.

2. On 2 April received the three volumes of the interim report "LIMITED ENERGY STUDY HIGH TEMPERATURE AND CHILLED WATER DISTRIBUTION SYSTEMS FOR STEWART AND HUNTER AAF, GEORGIA" prepared by Reynolds, Smith and Hills, Inc. of Jacksonville, Florida. NO ACTION REQUIRED.

3. SCOPE OF WORK: NO ACTION REQUIRED.

a. The scope of work (Appendix A, Volume II of the report) states that the Architect-Engineer (A-E) shall perform field investigations of the high temperature water (HTW) distribution systems and the chilled water (CHW) distribution systems and identify and document projects. One particular alternative project is the complete replacement of the existing distribution lines with a shallow trench distribution system.

b. For the Fort Stewart HTW field investigation, the A-E is to identify the location of energy leaks, describe and estimate the cost of the Energy Conservation Opportunities (ECOs) to close these leaks, and to perform a Life Cycle Cost Analysis (LCCA) to see if these ECOs qualify for funding under either the Federal Energy Management Program (FEMP) or the Energy Conservation Investment Program (ECIP). For the Hunter Army Airfield (HAAF) field investigation, the A-E shall gather data on the Central Energy Plant (CEP) and the pinwheel barracks energy plant and interview the personnel involved with the plants. The A-E will recommend on this investigation whether or not further study of the HAAF HTW distribution systems should be programmed for the future.

c. For both the Fort Stewart CHW and the HAAF CHW, the A-E shall gather data on the Central Energy Plant (CEP) and the pinwheel barracks energy plant and interview the personnel involved with the plants. The A-E will recommend on this investigation whether or not further study of the Fort Stewart and HAAF CHW distribution systems should be programmed for the future.

d. At the interim submittal review stage, Fort Stewart and Forces Command (FORSCOM) personnel are to give guidance to the A-E on how best to package the ECO's for funding purposes.

INTERIM

NO ACTION REQUIRED.

4. FACILITY DESCRIPTION:

a. Fort Stewart has a central energy plant (CEP) and satellite energy plant (SEP). The CEP has three natural gas/fuel oil-fired package boilers and one stoker-fired wood boiler and these boilers produce high pressure steam. The CEP uses the steam in three cascade heaters to produce high temperature hot water and to feed by underground steam line the two cascade heaters in the SEP about one mile away. The SEP has no boilers.

b. The CEP HTW distribution system has about seven miles of underground lines and serves about 130 buildings. The SEP serves five buildings with about one mile of underground distribution lines.

c. A large amount of wood is burned in the CEP. As a result, the energy costs are very low. Wood contributes about 86 percent of the yearly energy consumed.

5. Make-up water use was an important parameter in the estimation of the leak losses. Since a HTW is a closed system, the water loss from leaks would be the make-up water minus blowdown and sootblowing uses. The A-E analyzed three years of data and used the last year (1995) as the base to determine the leaks found during the surveys.

6. The A-E came up with 12 ECOs to analyze for project cost; savings-to-investment ratio (SIR); simple payback; utility energy savings for electricity and heating fuels; quantity of water savings; and dollar savings for energy, water, and operations and maintenance. The ECOs are:

Number 1: Replacement of the existing HTW distribution lines with a new shallow trench distribution system.

Number 2: Reduce blowdown of the cascade heaters and the wood-fired boiler.

Number 3: Reduce soot blowing, install an exit gas temperature indicator on the wood-fired boiler.

Number 4: Repair HTW and steam leaks in the CEP and SEP.

Number 5: Repair HTW leaks in the mechanical equipment rooms.

Number 6: Repair building side DHW and HVAC hot water leaks.

Number 7: Repair HTW leaks in valve pits, drain pits and valve boxes.

Number 8: Repair underground HTW distribution system leaks.

Number 9: Reduce or eliminate HTW discharge during SEP start-up.

- Option A. Improve start-up procedure for the SEP.
- Option B. Install a new condensate/HTW return pump in the SEP.

Number 10: Use an alternative heating method to reduce SEP operating cost.

- Option A. Distribute HTW from the CEP to the SEP instead of steam.
- Option B. Shut down the SEP and use individual oil-fired boilers in the buildings served by the SEP

Number 11: Purchase leak locator equipment or contract leak locator service when a major HTW leak occurs.

Number 12: Reduce boiler and HTW system operating pressure.

- Option A. Operate at 100 psig.
- Option B. Operate at 60 psig
- Option C. Operate at 30 psig
- Option D. Operate at 15 psig.

INTERIM

7. RESULTS:

The following are CECPW's comments about the various ECOs:

a. Number 1: Replacement of the existing HTW distribution lines with a new shallow trench distribution system. The replacement of the existing distribution system with a new shallow trench system is not economical (the simple payback is nearly 100 years). This would be expected since the current system is in relatively good shape. However, if the existing buried distribution system deteriorates to the point that the entire distribution system has to be replaced, the shallow trench system would probably be the system to use.

CONCUR. WILL RECOMMEND EVALUATION OF ABOVE GROUND SYSTEM WHEN EXISTING PIPING IS NEAR THE END OF ITS USEFUL LIFE

1. When designing the distribution system, the preference is for aboveground piping, followed by shallow concrete trench, and finally direct buried systems. The US Army Corps of Engineers has developed a new (October 1994) policy for heat distribution systems (HDS). This policy was developed because of many reports of poor performance of existing steam and high temperature hot water distribution systems. This policy is for Army heat distribution systems with a carrier pipe temperature 95 degrees C and above (See Policy below).

2. The Site Classifications are A, B, C, and D. These classifications are based on underground water conditions. Class A sites have severe underground water conditions. Any piping placed underground in Class A site will have water over the top of the piping. Site B has bad underground water conditions; Class C moderate and Class D mild.

3. Technical Manual TM 5-810-17, HEATING AND COOLING DISTRIBUTION SYSTEMS, May 1994, provides criteria and guidance for the design and construction of heating and cooling distribution systems. This manual says that in most circumstances, experience has shown that aboveground systems are the most life cycle cost effective. Experience has also shown that the M & R costs of shallow concrete trench systems are lower than for direct buried systems, and they must be included in the life cycle cost analysis.

b. Number 7: Repair HTW leaks in valve pits, drain pits and valve boxes. This is a very important repair because if the pit or manhole fills with water large energy losses can result. During the survey, several pits had water up to the piping. There is a draft USACERL Technical Report on "BOILING MANHOLE HEAT LOSS CALCULATIONS" prepared by Charles Marsh and Terrill Laughton. The overall objective of this project is to develop a set of correlations that can be used in the field to estimate the heat loss from a boiling manhole for an entire year. The heat loss estimation is then used to assess the economic impact on the operations cost of the heat distribution system. Four variables are needed to calculate the heat loss of a boiling manhole: the steam pressure, average steam velocity, the total length, and the average diameter of the steam piping in the manhole. The calculated energy loss in a flooded manhole with 19 feet of piping with an average diameter of 6.5 inches for a high pressure steam distribution system is $170,000 per year at average Army energy cost rates. There are also calculations for high temperature hot water distribution systems.

CONCUR. WATER LEVEL IN PIT IS FROM GROUND WATER LEAKING IN AND SUMP PUMPS THAT DO NOT WORK. PROBLEM IS ADDRESSED IN THE O&M RECOMMENDATION

c. Number 8: Repair underground HTW distribution system leaks. This is not covered in the interim report. A survey of selected sections of the distribution was scheduled for February 1996. A print out and explanation of Renewables and Energy Efficiency Planning (REEP) is attached. One of ECOs is Underground Heat Distribution Systems Repairs and is rated about the fourth or fifth best savings-to-investment ratio. Page 448 of the CERL report shows how the costs were calculated for underground heat distribution system leak repairs.

CONCUR. ECO-8 ANALYSIS PROVIDED AT REVIEW MEETING AND WILL BE INCLUDED IN PREFINAL RPT.

INTERIM

8. In summary, it is a good report. I agree with the methodology. The assumptions seem reasonable. Much of what I wrote above is for added information and shows some of the work that is going on at CERL. CECPW-EM point of contact is Dennis Vevang; COM (703) 806-6071; DSN 656-6071; FAX -5220; INTERNET dennis.i.vevang@cpw01.usace.army.mil.

NO ACTION REQUIRED.

Encl.

Dennis Vevang
Mechanical Engineer

CF: Commander, US Army Corps of Engineers
Savannah District, ATTN: Mr. Rob Callahan
100 West Oglethorpe Avenue,
P.O. Box 889
Savannah, Georgia 31402-0889

Response to Review Comments

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Date: May 28, 1996

Reviewer: Dennis Vevang, CECPW-EM
Construction Engineering Research Laboratories

Response by: William T. Todd, PE

Subject: Interim Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

Number	Dwg/Pg/Par.	Response	Review Action Comments
1 - 6	N. A.	N. A.	No action required.
7.a.	Section 4.4 ECO-1	Concur	Will add text to ECO-1 recommendations that states an above ground piping system should be evaluated when the existing system is near the end of its useful life.
7.b.	Section 4.4 ECO-7	Concur	No action required. Water found in the valve pits was primarily due to ground water leaking around the conduits and inoperable sump pumps. Water in the valve pits was usually not in contact with the HTW piping. The sump pump problem is addressed in the O&M Recommendations, Section 5.2.
7.c.	Section 4.4 ECO-8	Concur	No action required. A copy of the ECO-8 evaluation and recommendations was provided at the review meeting and will be included in the Pre-final Submittal.
8	N. A.	N. A.	No action required.

CC: C. Warren
File

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4/16/96

FAX FOR
Rob Callahan
FAX 912 - 652 - 5442
TEL - 5246

INTERIM

NARESH KAPUR, PE
404-669-5327

FORSCOM REVIEW COMMENTS ON INTERIM EEAP SUBMITTAL."LTD ENERGY STUDY HIGH TEMP AND CHILLED WATER DISTRIBUTION SYSTEMS, FT STEWART/HAAF,GA"

A VOLUME I

1. General. This submittal is well organized. Please refer to Aug 28 submittal of RECORDS ANALYSIS AND SITE SURVEY PLAN. The important observation data and recommendations should be incorporatd in this submittal. An addendum is ok. If any aspect of the study is to be discontinued, it should be documented and agreed to by all interested parties.

CONCUR. WILL BE INCLUDED IN PREFINAL REPORT AS APPENDIX A.1C

2. General. In sec 5, for tables 5.1-2, 5.1-4 and 5.1-5, add a column for total cost saving. Also correct total of all projects cost column in table 5.1-5.

CONCUR. WILL CORRECT AND CHANGE TABLE

3. General. pl discuss PROS and CONs of recommendation for reducing the operating pressure to 60, 30, or 15 psig.

CONCUR. WILL ADD TO ECO-12 RECOMMENDATION

4. Vol I, pg 5-4. Elaborate 3,4,&5. For 7&8, have these been done? These are O&M items.

CONCUR. WILL ELABORATE. ALL ARE O&M ITEMS.

B. VOLUME II

5. ECO #1. Consider adding ECO description up front. This can be be done by repeating the descriptions from vol I. This will make the report more user friendly. Make special effort to look for non-energy savings and non recurring savings. This comment may be applicable to other ECOs also.

CONCUR. WILL ADD DESCRIPTION AND COMMENT ON AGE OF THE SYSTEM.

6. ECO # 2. Add a brief discussion on boiler water quality issue.

CONCUR. TEXT ADDED TO ECO-2 AND SECTION 4.3

7. ECO #8. This ECO is very important. Need to describe it in detail. What approach is being taken to come up with Life Cycle coct Analysis (LCCA).

CONCUR. ECO-8 INCLUDED IN PREFINAL RPT.

8. Some appendices are missing. Are these ready now?

CONCUR. ALL APPENDICES WILL BE INCLUDED IN PREFINAL RPT.

C. VOLUME III

9. Appendix B. Consider summerizing the pit valves and fittings survey form data on a spreadsheet. add an extra row for remarks as needed. 90 plus pages can be substituted by 3-4 pages of spreadsheet. Consider the same for appendix B2.

CONCUR. SUMMARY OF VALVE PITS AND MECH. ROOMS WILL BE IN PREFINAL RPT

10. Appendix B4. Status?

CONCUR. WILL BE INCLUDED IN PREFINAL REPORT.

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Response to Review Comments

Date: May 29, 1996

Reviewer: Naresh Kapur, AFPI-ENO
U. S. Army Forces Command

Response by: William T. Todd, PE

Subject: Interim Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

Number	Dwg/Pg/Par.	Response	Review Action Comments
1	Vol. I, General	Concur	The 8/28/95 submittal will be included in the Pre-final Submittal as Appendix A.10.
2	Vol. I, Section 5.1	Concur	All tables will be corrected and modified for the Pre-final Submittal.
3	Vol. I, General	Concur	A discussion about operating at reduced pressures will be added to the ECO-12 recommendations in Section 4.4.
4	Vol. I, Pg 5-4	Concur	Will elaborate on items 3, 4, and 5. All of these are O&M recommendations.
5	Vol. II, ECO-1	Concur	A description of ECO-1 and a comment on the age and condition of the existing piping system will be added.
6	Vol. II, ECO-2	Concur	A discussion on boiler water quality and treatment will be added as Section 4.3 and included in Section 4.4, ECO-2.
7	Vol. II, ECO-8	Concur	Calculations, analysis and recommendations for ECO-8 will be included in the Pre-final Submittal.
8	Vol. II, General	Concur	All appendices will be included in the Pre-final Submittal.
9	Vol. III App. B.1 & B.2	Concur	A summary list of findings for valve pits and mechanical rooms will be added for Sections B.1 and B.2, respectively.
10	Vol. III App. B.4	Concur	The forms for Section B.4 will be included in the Pre-final Submittal.

CC: C. Warren
File

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..BILE DISTRICT PROJECT REVIEW COMMENTS:	DATE: 18 July 1996	Page 1 of 1
TO: Rob Callahan, CESAS-PM-MP USAED, Savannah	FROM: Anthony W. Battaglia, CESAM-EN-DM Phone: (334) 690-2618 FAX: (334) 690-2424	

PROJECT/FY: FY95 EEAP Limited Energy Study, HTW Distribution

LOCATION: Fort Stewart, GA

TYPE REVIEW: Pre-final Submittal

NO.	Page/Par	COMMENT	Response to Comment
1.	General	The statistical analysis of the makeup water data was a very good approach; it allowed some sense to made of what could have been very confusing.	CONCUR
2.	Pg 2-2	Figure 2.2-1: On page 3-3 and on page 4-1, there are references to condensate and HTW return lines from the SEP to the CEP. Please include these lines in Fig 2.2-1.	CONCUR
3.	Pg 3-1	Par 3.2: Some additional losses that could be included are the deaerator vent and any steam traps that dischrge to the atmosphere or to a floor drain.	CONCUR
4.	Pg 3-4	On the first line, it appears that the phrase, "subtracted from" should be changed to "added to".	CONCUR
5.	Pg 4-42	Analysis - Option B: Change "50 psig" to "35 psig".	CONCUR
6.	Pg 4-42	Analysis - Option C: Are the boilers at the hospital currently being operated, or are they sitting idle?	CONCUR
7.	Pg 4-43	Analysis - Option D: The discussion of the HTW-to-Steam generators should be clarified. The temperature of the HTW must be higher than the saturation temperature corresponding to the desired steam pressure, otherwise there will be no heat transfer.	CONCUR
8.	Pg 4-43	Results and Recommendations: Options C & D should include an operation and maintenance cost for the operation of the hospital boilers.	CONCUR

Response to Review Comments

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Date: August 20, 1996

Reviewer: Anthony W. Battaglia, CESAM-EN-DM
U. S. Army Engineer District, Mobile

Response by: William T. Todd, PE

Subject: Pre-final Submittal
Limited Energy Study, HTW Distribution System, Fort Stewart
DACA01-94-D-0038, RSH #694-1331-002

Number	Dwg/Pg/Par.	Response	Review Action Comments
2	Volume I Pg 2-2	Concur	The terms “HTW return” and “condensate return” are used interchangeably in the text. To avoid confusion “condensate return” will be changed to “HTW return” on page 3-3. Figure 2.2-1 will be revised to show the HTW return pipe.
3	Volume I Pg 3-1	Concur	This sentence will be modified to: “The known system losses include soot blowing, boiler blowdown, cascade heater blowdown, the deaerator vent and other miscellaneous leaks within the CEP.”
4	Volume I Pg 3-4	Concur	The SEP tests quantified the leak rate from the SEP without blowdown so the blowdown should not be subtracted from the results. This sentence will be changed to: “The amount of water used for blowdown and other miscellaneous leaks must be added to the estimated loss rate from the above procedure to determine the total HTW losses from the SEP.”
5	Volume I Pg 4-42	Concur	Will change “50 psig” to “35 psig” in the second sentence of Analysis - Option B.

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6	Volume I Pg 4-42	Concur	To clarify this point the text will be modified to: "The existing heating and cooling plant at the hospital is only utilized when the CEP is not operational."
7	Volume I Pg 4-43	Concur	In order provide a sufficient temperature difference to produce steam at 15 psig, the steam generators require a minimum HTW system pressure of 25 to 30 psig. Therefore, Option D will be removed from this ECO.
8	Volume I Pg 4-43	Concur	Will add operation and maintenance costs for Option C.

CC: C. Warren
File

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A.8 LIST OF ABBREVIATIONS AND ACRONYMS

ABBREVIATIONS

ABMA	American Boiler Manufacturer's Association
ABS	Absorption
Btu	British thermal units
BFP	Boiler Feed Pump
BFW	Boiler Feed Water
C-1	Cascade Heater No. 1
CEP	Central Energy Plant
CHW	Chilled Water
DA	Deaerator
DHW	Domestic Hot Water
DPW	Directorate of Public Works
ECO	Energy Conservation Opportunities
EEAP	Energy Engineering Analysis Program
FEMP	Federal Energy Management Program
FSEO	Fort Stewart Energy Officer
GPD	Gallons per Day
GPM	Gallons per Minute
HHW	Heating Hot Water
HPS	High Pressure Steam
HTW	High Temperature Water
HTWR	High Temperature Water Return
HTWS	High Temperature Water Supply
kGal	1,000 Gallons
LF	Linear Feet
LPS	Low Pressure Steam
MBtu	Million British thermal units
MPS	Medium Pressure Steam
MUW	Make-up Water
O&M	Operation and Maintenance
OMA	Operation and Maintenance, Army
P&A	Puckorius & Associates
PPM	Parts per million
PRS	Pressure Reducing Station
psig	pound per square inch
RS&H	Reynolds, Smith and Hills, Inc.

SEP	Satellite Energy Plant
SIR	Savings to Investment Ratio
TDS	Total Dissolved Solids
WM	Water Meter
WS	Water Softener

A.9 CORRESPONDENCE AND MEETING NOTES

CSW

DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 889
SAVANNAH, GEORGIA 31402-0889

REPLY TO
ATTENTION OF:

Military Branch

SUBJECT: Request for Proposal for Delivery Order No. 2 Under Contract No. DACA01-94-D-0038, Indefinite Delivery Contract for Architect-Engineer Services for the Army Energy Engineering Analysis Program (EEAP) for the Southeast Region, Including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Puerto Rico, and South Carolina

Reynolds, Smith and Hills, Incorporated
Attention: Mr. Carlos Warren
4651 Salisbury Road
Jacksonville, Florida 32256

Gentlemen:

I refer to the conversation of February 17, 1995, between Mr. Carlos Warren of your firm and Mr. Rob Callahan of the Savannah District regarding the incorporation of work into your referenced contract. The work is described in the attached Appendix A for Delivery Order Number 2.

There will be a prenegotiation conference in building number T-1139 at Fort Stewart on February 28, 1995, beginning at 9:00 am. Your firm should be appropriately represented at the meeting and be prepared to ask any questions you need to clarify the Appendix A for this project.

Please furnish your fee proposal in detail by separate item of work as outlined on the attached "Suggested Format for Architect-Engineer Fee Proposal" to the attention of the Architect-Engineer Contract Section (CESAS-EN-EA) by March 8, 1995. The estimate shall include all project costs.

You are to mark the envelope containing your fee proposal in the lower left corner "Architect-Engineer Fee Proposal". After receipt of your fee proposal, you will be contacted by an approved District negotiator for the purpose of establishing a date for fee negotiations.

You are not to proceed with this work until the negotiations are concluded and the notice to proceed is issued. You are cautioned that your participation in the prenegotiation conference and the preparation of your fee proposal are entirely at your own risk. Further, in the event of unsatisfactory fee negotiations, the Government can assume no obligation for payment

of any expense incurred by your firm in the preparation of your fee. The award of delivery orders is subject to the approval of the Contracting Officer.

If you have any questions concerning this additional work, please contact the Project Manager, Mr. Rob Callahan, of the Reimbursable Management Team, at telephone number (912) 652-5426.

Sincerely,

Warren T. Clarke

Warren T. Clarke
Authorized Representative of the
Contracting Officer

Attachment

Copies Furnished (wo/enclosures):

Commander, 24th Infantry Division and Fort Stewart, Attention: AFZP-DEV (Mr. Randy Jones), Fort Stewart, Georgia 31314

Commander, U.S. Army Forces Command, Attention: AFPI-ENO (Mr. Naresh Kapur), Fort McPherson, Georgia 30330

2/27/95

FORT STEWART SURVEY

A. PRE-SURVEY

1. OBTAIN SET OF DISTRIBUTION SYSTEM MAPS FROM FT S. GIS OPERATOR / SYSTEMS ANALYSIS BRANCH

2. OBTAIN COPY OF ANY PREVIOUS STUDIES

3. COPY OF WORK ORDERS AND/OR SERVICE ORDERS PAST 12 MONTHS FROM RESOURCES MGT DIV / FE DIVISION

4. INTERVIEW PERSONNEL — (?) INCLUDE HAAF

5. REVIEW MAKE-UP WATER LOGS

B. DEVELOP PLAN

C. FIELD SURVEY

1. Develop data forms

2. APPOINT FIELD SURVEY MANAGER

2/28/95

PRE-NEGOTIATE

1. 14,000 gal/day HTW make-up

2. HAAF study option.

3. Randy wants system evaluation. (distribution only)

MEMORANDUM FOR RECORD

SUBJECT: Prenegotiation Conference for Delivery Order No. 2 under Contract No. DACA01-94-D-0038, Indefinite Delivery Contract for Architect-Engineer Services for the Army Energy Engineering Analysis Program (EEAP) for the Southeast Region including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Puerto Rico, and South Carolina

1. The undersigned called the subject meeting to order on 28 February 1995 at 0900 in the Fort Stewart DPW conference room. I stated the purpose of the meeting and circulated the sign-in sheet. Project team members in attendance are shown at encl 1.

2. Everyone had already introduced themselves, so we proceeded on into our review of the draft Appendix A, or Scope of Work, for the project. We immediately got sidetracked into discussing additions to the Scope. We bounced ideas around, performed a map review, and then broke for lunch. Following lunch, we reconvened the meeting in the Central Energy Plant (CEP) manager's office. When we finished there, we did a short field investigation of some exposed distribution system piping and a few valve pits and placed a telephone call to the Repair Branch supervisor, Gene Smith, to solicit his thoughts on where water leaks exist. We discussed survey techniques that the A-E would use for the project. We decided if the A-E had to remove any pipe insulation in order to attach flow meters that Doug would initiate a DPW work request to have it repaired so that the A-E's field crew would be relieved of this responsibility.

3. The conclusion of the team from the day's work was that I would redraft the Appendix A to incorporate more work and that the work needed to proceed in a different sequence from that which I had described in the draft Scope.

4. The final revised version of the project Appendix A is attached at encl 2. It incorporates all the changes needed to bring the Scope into line with the customer's desires.

5. The order in which the A-E will perform the work now will be:

a. Perform the review of records on the Fort Stewart (FS) chilled water system (CHW).

b. Perform the review of records on the Hunter Army Airfield (HAAF) high temperature water systems (HTW) and CHW systems for both the CEP and the pinwheel barracks energy plant.

c. Submit recommendations, with back-up justification, on the FS CHW distribution system and the HAAF HTW/CHW systems along with the plan for the field investigation. The field investigation plan will address both the FS HTW and CHW system surveys, if the A-E's recommendation is to perform the detailed field study of the FS CHW

system.

d. Perform the field investigations.
e. Submit the interim report.
f. Submit the pre-final report.
g. Submit the final report.

6. Doug, Carlos, and I signed our Partnering Agreement (encl 3). I adjourned the meeting at about 1400.

Robert A. Callahan

Robert A. Callahan
Project Manager

CONFERENCE PARTICIPANTS

Project High Temp & Chilled Water Distribution System Study	Date: 28 Feb 95
Base: Ft. Stewart	Time: 0900
Fiscial Year 1995	Local:
Line Item	Type: Pre-negotiation

Name	Position	Organization	Office Sym.	Telephone
1. Rob Callahan	Project Manager	Corps of Engineers Savannah District	CESAS-PM-MR	(912) 652-5246 DSN: 971-6330, ext. 524
2. Randy Jones	Energy Coordinator	DPW Energy	AFZP-DEV	~~912 654-~~ 912 767-7925
3. D.H. Swanson	Energy Eng	DPW Energy	AFZP-DEV	352-5535 912-767-8880
4. W.T. Todd	Engineer	RS&H	—	904-279-2281
5. Carlos Warren	Proj Mgr.	RS&H		904-279-2275
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DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS
P.O. BOX 889
SAVANNAH, GEORGIA 31402-0889

REPLY TO
ATTENTION OF:

CESAS-PM-MP-2 8 Mar 95

MEMORANDUM FOR

Commander, 24th Infantry Division & Ft. Stewart, ATTN: AFZP-DEV (Mr. Swanson), Ft. Stewart, GA 31314
Commander, U.S. Army Forces Command, ATTN: AFPI-ENO (Mr. Kapur), Ft. McPherson, GA 30330
Commander, U.S. Army Engineer Division, South Atlantic, ATTN: CESAD-EN-TE (Mr. Baggette), 77 Forsythe Street, SW, Atlanta, GA 30335-6801
Commander, U.S. Army Engineer District, Mobile, ATTN: CESAM-EN-DM (Mr. Battaglia), P.O. Box 2288, Mobile, AL 36628-0001

SUBJECT: Delivery Order No. 2 Under Contract No. DACA-01-D-0038, Indefinite Delivery Contract for Architect-Engineer Services for the Army Energy Engineering Analysis Program (EEAP) for the Southeast Region Including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Puerto Rico, and South Carolina

I am enclosing the minutes of the Prenegotiation Conference for the subject project held at Fort Stewart on 28 Feb 95. Please advise the Project Manager, Rob Callahan, of any additions, deletions, or corrections to these minutes.

FOR THE COMMANDER:

Warren T. Clarke

Encl

WARREN T. CLARKE, R.A.
Acting Chief, Military Programs and
Project Management Branch

CF:
Reynolds, Smith and Hills, Inc., ATTN: Mr. Carlos Warren, 4651 Salisbury Road, Jacksonville, FL 32256

CONFERENCE PARTICIPANTS

Project	HHW & CHW Dist. Study	Date:	6/28/95
Base:		Time:	1330
Fiscial Year		Local:	Ft Stewart GA
Line Item		Type:	

Name	Position	Organization	Office Sym.	Telephone
1. Rob Callahan	Project Manager	Corps of Engineers Savannah District	CESAS-PM-MR	Com (912) 652-5246 DSN 971-6330, ext. 524
2. Naresh Kapur	Mech Engr	HQ. FORSCOM DCSPIM - Engr	AFPI-ENO	COM 404-669-5327 FAX 7751
3. Roger Cruz	DPW Repairs			767-2138
4. Doug Swanson	DPW - Energy	DPW - ENRD	AFZP-DEV	352-5535
5. Bill Todd	Mech. Eng.	RS&H	Jax	904-279-2281
6. Carlos Warren	Proj. Mgr	RS&H	JAX	904-279-2275
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MEETING NOTES

6/28/95

- $10.82 /ton for wood chips

- Chilled water pipe is asbestos with asbestos insulation and asbestos pipe jacket.

- 600 Block 1st
  700 Block 2nd } not as many leaks even though ~~these are the oldest systems.~~
  800 Block

- Records review
  - HTW at Ft Stewart
  - CHW at " "
  - HTW at Hunter
  - CHW at "

- Chris Harley in charge of Boiler Plant

- Doug S. is place to start for information.

- Meter at valve pits and test potable water for sulfite or other boiler feed water chemical.

* Check on type of insulation on High Temp. Pipes

- Worst problem is 4500 block - the newest system
  - This loop is shut down during the summer water sits in the pipe all summer

A.9-9

wtt
(2)

6/28/95

- EEAP Study for capacity of system and load of buildings on the system

- Cost Est.
  ECO Analysis
  Form 1391 later ?

- Rob's schedule is about 52 weeks.

- Coordinate F.Survey w/ boiler plant operation.

- Have Doug write a memo giving us access to the base to perform the survey

CHW - 120 psi for Zone 1 & 2
80 psi for Zone 3 which is the longest run

- Zone 1: 700 & 800 Block - must keep pressure up for these areas
- Zone 2 bldg 440 - not cooled properly unless pressure is high

RS&H
Architectural, Engineering, Planning and Environmental Services

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
904•296•2000
Fax 904•279•2491

FL. Cert Nos AAC001886 • EB0005620 • LCC000210

July 19, 1995

Department of the Army
Savannah District
Corps of Engineers
100 W. Oglethorpe Avenue
Savannah, GA 31402-0889

Attn: Warren T. Clarke
Contracting Officer Representative

Subject: **Contract No. DACA01-94-D-0038**
Delivery Order Number 2
Limited Energy Study of High Temperature and Chilled Water Distribution Systems at Fort Stewart and Hunter Airfield, Georgia
AEP File No. 6941331002

Gentlemen:

Pursuant to Paragraph 5.1, Appendix A of the referenced Delivery Order, the following individuals are designated:

Project Manager	Carlos S. Warren, PhD, PE
Field Survey Manager	William T. Todd, PE

Your concurrence is respectfully requested.

Very truly yours,

Carlos S. Warren, PhD, PE
Vice President - Energy Services

/gk
cc W. Todd
Distribution

DISTRIBUTION

Commander
24th Infantry Division and Fort Stewart
ATTN: AFZP-DEV (Mr. Doug Swanson)
Fort Stewart, GA 31314

Commander
U. S. Army Forces Command
ATTN: AFPI-ENO (Mr. Naresh Kapur)
Fort McPherson, GA 30330

Savannah District, Corps of Engineers
ATTN: CESAS-PM-MR (Mr. Rob Callahan)
100 W. Oglethorpe Avenue
P. O. Box 889
Savannah, GA 31402-0889

Mobile District, Corps of Engineers
ATTN: CESAM-EN-DM (Mr. Tony Battaglia)
P. O. Box 2288
Mobile, AL 36628-0001

RS&H

MEMORANDUM

Date: 1 September 1995

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MR (Mr. Rob Callahan)
PO Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Monthly Progress Report
Limited Energy Study, Hunter Army Airfield and Ft. Stewart
HTW and CHW Distribution Systems
Contract No. DACA01-94-D-0038/0002

The following progress was made on the subject contract during the month of August 1995:

1. Site visit was accomplished by the Project Manager (PM) and the Site Survey Manger (SSM) 02 - 04 August. The purpose of the site visit was to gather sufficient data and records to recommend whether or not to conduct detailed surveys and analyses of the HAAF CHW and heating distribution lines and the Ft. Stewart CHW distribution lines.

2. Additional data and drawings were also obtained on the Ft. Stewart HTW distribution system.

3. The scheduled report "Records Analysis and Site Survey Plan" was distributed on 28 August 1995.

Work planned for September 1995:

1. Begin activities to prepare for the initial site survey scheduled to begin 23 October 1995. Equipment and necessary subcontractors will be committed. If judged worthwhile, the site survey may be started ahead of schedule.

cc: Doug Swanson

RS&H
Telephone Call Confirmation

Project Number 694-1331-002

Local ______ L.D. (circled) ______ Placed ______ Rec'd (circled) ______ Date 9-6-95

Conversed with Rob Callahan Of COE - Savannah District

Regarding Fort Stewart HTW Distribution Study

They have just hired a new energy coordinator at Fort Stewart. His name is Tim Harper and he will be replacing Doug Swanson as our point of contact for this project. His office is in the FE Division and his temporary phone number is 912-767-2446. I told Rob I would call Tim this week to get acquainted. They would also like a week or two advance notice prior to each site visit. Rob has reviewed the survey plan and is very pleased/impressed with it.

There is a design and construction contractor that would like to "look over our shoulder" during the site survey. I said that would be ok as long as they did not slow us down.

Distribution: C. Warren

8T

RS&H®

September 15, 1995

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: William T. Todd, PE
Field Survey Manager

Subject: **Weekly Field Survey Progress Report**
Limited Energy Study
Hunter Army Airfield and Ft. Stewart
HTW and CHW Distribution Systems
Contract No. DACA01-94-D-0038/0002

The following progress was made on the subject contract during the week ending 15 September 1995:

1. Site visit was accomplished b the Field Survey Manager on 13 September. The purpose of the site visit was to:

   A. Locate HTW system make up water, chemical feed and blow down pipes to be metered and determine if pipe insulation removal is required. The make up water pipe was located and flow estimates for the two chemical feed systems and 12 blow down systems were obtained from conversations with the plant operations staff. Some pipe insulation will have to be removed if the metering effort is required. The CEP operations staff will be notified after a decision has been made.

   B. Obtain copies of recent HTW and potable water sample analysis reports. Copies of analysis reports for boiler water, cascade heater water (HTW), make up water, condensate, and cooling tower make up water (potable water) were obtained from the CEP records.

2. Pump and pump motor nameplate data was taken for the three HTW system zones served by the CEP. This effort was originally scheduled for the October field survey, however, time permitted it during this visit. We can now go ahead and pursue the pump curves from the manufacturer.

Additional field survey work planned for September 1995:

1. No additional field survey work is planned until the initial site survey which is scheduled to begin 23 October 1995. If judged worthwhile, the initial site survey may be started ahead of schedule. We will notify the FESO and Savannah District accordingly.

/gk
cc Tim Harper

Transmittal Letter

RS&H
Architecture, Engineering and Planning

To: Mr. Robert Meston
Utility Services Assoc. Inc.
10013 Martin Luther King Jr. Way, S.
Seattle, WA 98178

Date: 9/20/95

Project: Fort Stewart
HTW and CHW Distribution

Project No: 694-1331-002

We Transmit:
(X) herewith
( ) under separate cover

For Your:
( ) approval
(X) review & comment
(X) use

The Following:

Copies	Date	Description
1	---	Piping System Information
1	---	HTW Distribution System Map

Remarks: Please prepare a quote for USA to provide leak detection and locating services based on the attached information.

Copies To: C. Warren

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
904•296•2000 Fax 904•279•2491

FL. Cert. Nos. AAC001886 • EB0005620 • LCC000210

By: William T. Todd
William T. Todd, PE

RS&H

MEMORANDUM - VIA FAX *Architectural, Engineering, Planning and Environmental Services*

To: Mr. Tim Harper **Date:** 9-27-95
From: William T. Todd
Project: Fort Stewart HTW Leak Study
A/E No.: 694-1331-002
Subject: Building Hot Water Generator Survey

This memo is to provide written conformation of our telephone conversation regarding the building hot water generator survey planned for next week. As we discussed, our team will be at Fort Stewart for three to five days beginning Monday morning (10-2-95). We will be taking water samples from buildings that utilize the HTW system to produce domestic hot water.

Also, as per our conversation, please have a letter of authorization prepared that will allow us access to the buildings. The survey team will consist of the following people:

William T. Todd, Field Survey Manager
Paul F. Hutchins
George W. Fallon

Please call me if you have any questions. I look forward to meeting you next week.

Copies To: Mr. R. Callahan (Via Fax)
C. Warren

FORT STEWART, ENRD, ENVIRONMENTAL BRANCH

Date: 28 SEPT 95
Number of Pages (inc. cover sheet): 2

To: Bill Todd	From: Tim Harper
Phone:	Phone: 912-767-4903
Fax:	Fax:
CC:	

Remarks: ☐ Urgent ☐ For your review ☐ Reply ASAP ☐ Please comment

Bill,

I believe this will be sufficient! Let me know if you need anything else. Look forward to meeting w/ you next week.

Tim Harper

AFZP-DEF (420-10a) 28 Sep 95

MEMORANDUM FOR RECORD

SUBJECT: Water samples for Fort Stewart HTW Leak Study

1. The week beginning 2 Oct 95, RS&H will be at Fort Stewart taking hot water samples. The following individuals will need to enter buildings that utilize the HTW system: William T. Todd (Field Survey Manager), Paul F. Hutchins, and George W. Fallon.

2. POC is Tim Harper, extension 4903.

Timothy D. Harper

TIMOTHY D. HARPER
Energy Engineer, FE Division

RS&H®

October 6, 1995

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: William T. Todd, PE wtt
Field Survey Manager

Subject: **Weekly Field Survey Progress Report**
Limited Energy Study
Ft. Stewart HTW Distribution System
Contract No. DACA01-94-D-0038/0002

The following progress was made on the subject contract during the week ending 6 October 1995:

1. Site survey was performed by Paul Hutchins, George Fallon and the Field Survey Manager from 2 - 4 October, 1995. The following items were accomplished during the site visit:

   A. The HTW distribution system leaks were determined by turning off all blow down and soot blowers in the CEP for 8 hours and measuring the makeup water required to refill the cascade heaters. This test will be performed again when the satellite energy plant is operational.

   B. Obtained HTW, domestic hot water and potable water samples for analysis. The analysis will be used to determine if the heat exchangers are leaking HTW into the domestic hot water generators in the barracks and dining facilities.

Additional field survey work planned:

1. No additional field survey work is planned until the satellite energy plant (SEP) is operational. This survey, which will include valve pits and mechanical rooms, is scheduled to begin 6 November 1995. If the SEP is not operating, the site survey may be started at a later date. We will notify the FESO and Savannah District accordingly.

/gk
cc T. Harper (FESO)
C. Warren (PM)

RS&H

MEMORANDUM ***Architectural, Engineering, Planning and Environmental Services***

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

Date: 26 October 1995

From: Carlos S. Warren, PhD, PE
Project Manager

Project: Limited Energy Study - Hunter Army Airfield and Ft. Stewart
HTW and CHW Distribution System
Contract No. DACA01-94-D-0038/0002
A/E No. 694-1331-002

Subject: Monthly Progress Report

The following progress was made on the subject project during the month of October 1995:

1. Site survey was accomplished the week of 2 October 1995. The purposes of the site visit were to obtain potable water samples from the buildings with HTW generators to identify possible water leaks from the heat exchanger in the generator, and to measure the makeup water required to refill the cascade heaters. A report on the survey was submitted by the Field Survey Manager to the addressee on 6 October 1995.

2. The analysis of the water samples was received on 23 October 1995. Of the 53 buildings sampled, 22 samples showed sufficient quantities of phosphates and/or sulfates (present in the HTW) to suspect leaks.

3. Observations were made of leak detection in underground water lines using ultrasonic technology. This method will be used to survey the Ft. Stewart HTW lines. The equipment and operator have been tentatively scheduled for a survey the week of 15 January 1996.

Work planned for November 1995:

1. Survey of the valve pits and mechanical rooms containing suspected HTW heat exchanger leaks will commence when the satellite energy plant is operational.

Copies To: Tim Harper (FESO)
W. Todd

A.9-22

RS&H

Architectural, Engineering, Planning and Environmental Services

MEMORANDUM - VIA FAX

To: Mr. Tim Harper **Date:** 11-3-95

From: William T. Todd

Project: Fort Stewart HTW Leak Study

A/E No.: 694-1331-002

Subject: Field Survey Schedule

Our next field survey of the Fort Stewart HTW distribution system is scheduled to take place next week (11/06/95-11/10/85). One of the main objectives of this survey is to determine the total volume of HTW losses during full heating operation. However, as described in our most recent progress report, the Satellite Energy Plant (SEP) must be operational so we can quantify the leakage rate of the entire HTW distribution system during the heating season.

I called the operator of the Central Energy Plant today and he said the SEP was still not operating. He expected it would be running within the next couple of weeks. We will check on the status of the SEP each week and schedule the next field survey as soon as possible after the SEP is operational.

Please call me if you have any questions regarding the field survey schedule.

Copies To: Mr. R. Callahan (Via Fax)
C. Warren

AFZP-DEF (420-10a) 27 Nov 95

MEMORANDUM FOR RECORD

SUBJECT: Fort Stewart HTW Leak Study

1. The week beginning 27 Nov 95, RS&H will be at Fort Stewart taking hot water samples. The following individuals will need to enter buildings that utilize the HTW system: William T. Todd (Field Survey Manager) and George W. Fallon.

2. POC is Tim Harper, extension 4903 or 9451.

Timothy D. Harper

TIMOTHY D. HARPER
Energy Engineer, FE Division

BT

RS&H

MEMORANDUM *Architectural, Engineering, Planning and Environmental Services*

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

Date: 29 November 1995

From: Carlos S. Warren, PhD, PE
Project Manager

Project: Limited Energy Study - Hunter Army Airfield and Ft. Stewart
HTW and CHW Distribution System
Contract No. DACA01-94-D-0038/0002
A/E No. 694-1331-002

Subject: Monthly Progress Report

The following progress was made on the subject project during the month of November 1995:

1. Evaluated the test results of the domestic hot water samples and selected buildings to revisit and perform leak tests.

2. Began writing Introduction, Facility Description and Methodology sections of Interim Report.

3. Site survey was accomplished during the week of 27 November 1995. The following items were accomplished during this field investigation:

   - Measured make up water to the CEP during heating season.
   - Measured make up water to the SEP
   - Surveyed valve pits
   - Surveyed more mechanical equipment rooms
   - Measured miscellaneous leaks within the CEP and the SEP

Work planned for December 1995:

1. Analyze data collected during field investigations and calculate annual cost of HTW distribution system leaks.

2. Continue drafting Interim Report.

Copies To: Tim Harper (FESO)
W. Todd

Transmittal Letter

RS&H
Architecture, Engineering and Planning

To: Commander
24th Infantry Division and Ft. Stewart
ATTN: AFZP-DPW-OB FAC DIV (Mr. Randy Parks)
Fort Stewart, Georgia 31314-5000

Date: 12/8/95

Project: Fort Stewart HTW Distribution System Study

Project No: 6941331002

We Transmit:
(X) herewith
( ) under separate cover

For Your:
( ) approval
( ) review & comment
(X) use

The Following:

Copies	Date	Description
1	---	Fuel Tank Capacity (w/o baffle) by height in inches
1	---	Fuel tank capacity (with baffle) by height in inches

Remarks: These are good estimates of the usable fuel tank capacities, one with and one without a baffle. If George measured the tanks correctly, these values should be accurate within 10 to 15 gallons. Please call me if you have any questions.

Copies To:

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
904•296•2000
Fax 904•279•2491

By: Bill Todd
William T. Todd, PE

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: December 28, 1995

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of December 1995:

1. Added water temperature data, reevaluated the test results of the domestic hot water samples and selected buildings to revisit and perform leak tests.

2. Continued working on draft of Interim Report.

3. Analyzed data collected during November field investigation. Results of the analysis include:

   - Test to measure make up water to Zones 1, 2 and 3 during heating season were inconclusive. We will retry this test during January site visit.

   - Test to measure make up water to the SEP Zone indicated this was a very tight distribution system.

   - Began calculations to quantity leaks found during survey of valve pits, mechanical equipment rooms, the CEP and the SEP.

4. Canceled ultrasonic leak detection test scheduled for January based on the low volume flow of leaks within the distribution system (less than 4 g.p.m.).

5. Investigating video thermography to locate HTW system leaks.

Monthly Progress Report
Memorandum to Callahan
28 December 1995
HAAF and Ft. Stewart HTW and CHW Distribution Systems

Work planned for January 1996:

1. A field investigation is scheduled for January 15-19. The goals are:

   - Survey remaining mechanical rooms (approximately 60) for leaks.
   - Test hot water generator/heat exchangers suspected of leaks.
   - Repeat test for make-up water to Zones 1, 2 and 3.

2. Analyze data collected during field investigations and calculate annual cost of HTW distribution system leaks.

3. Continue drafting Interim Report.

/gk
Copies to: T. Harper (FESO)
W. Todd

RS&H

MEMORANDUM

February 5, 1996

TO:	Savannah District, Corps of Engineers ATTN: CESAS-PM-MP (Mr. Rob Callahan) P. O. Box 889 Savannah, GA 31402-0889
FROM:	Carlos S. Warren, PhD, P.E. - Project Manager
SUBJECT:	Monthly Progress Report Contract No. DACA01-94-0038/0002 Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of January 1996:

1. Performed field investigation to survey about 60 mechanical equipment rooms, test hot water generators/heat exchangers for leaks and correct errors to make-up water use data.

2. Continued working on project analysis and draft of Interim Report.

3. Scheduled the ultrasonic leak detection test for February 21-23.

4. Investigated video thermography to locate HTW system leaks. Rejected this method based on high costs.

Work planned for February 1996:

1. A field investigation is scheduled for February 21-23. The goals are:

   - Survey selected sections of the underground HTW distribution piping.

   - Use ultrasonic leak detection equipment to locate leaks.

2. Complete analysis and submit Interim Report.

/kw

cc: T. Harper (FESO)
W. Todd

RS&H

MEMORANDUM

February 5, 1996

TO: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

FROM: William T. Todd, P.E.
Field Survey Manager

SUBJECT: **Weekly Field Survey Progress Report**
Limited Energy Study
Hunter Army Airfield and Ft. Stewart
HTW and CHW Distribution Systems
Contract No. DACA01-94-D-0038/0002

The following field investigation progress was made on the subject contract during the week ending 19 January 1996:

1. Site visit was accomplished on 16-18 January. The purpose of the site visit was to:

   A. Survey remaining mechanical rooms (about 60 rooms) for HTW leaks.

   B. Test hot water generators and heat exchangers suspected of leaking.

   C. Correct errors and explain extreme data from boiler logs.

Additional field survey work planned:

1. The next and final field survey work is planned for February 21-23. We will be testing the underground HTW pipes using ultrasonic leak detection equipment.

/kw

cc: Tim Harper
N. Kapur (via fax)
C. Warren

I:\todd\sav\02-05.mem

Transmittal Letter

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

To:	Attached Distribution List	Date:	February 16, 1996
Project:	Limited Energy Study HTW and CHW Distribution Systems Fort Stewart and Hunter AAF	Project No.:	6941331002

We Transmit:

(X) Herewith ( ) Via Fax ( ) Hand Carried
( ) Under Separate Cover Via:
( ) In Accordance with Your Request
( ) Regular Mail (X) Overnight Mail ( ) Courier

For Your:

( ) Approval
(X) Review and Comment
( ) Use
( ) Signature

The Following:

Copies	Date	Description
As per distribution list	2-19-96	Interim Submittal -Vol. I Narrative Report
As per distribution list	2-19-96	Vol. II Appendicies
As per distribution list	2-19-96	Vol. III Field Investigation Forms

Remarks: Volume III is being supplied in 3-ring binders because these forms will not change. Updated covers and inserts will be sent with future submittals.

/kw
Copies To:

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491

FL Cert. Nos. AAC001886•EB0005620•LCC000210

By: William T. Todd
William T. Todd, P.E.

I:todd\int.rpt

A.9-32

Limited Energy Study
HTW and CHW Distribution Systems
Fort Stewart and Hunter AAF

INTERIM REPORT

NO. COPIES

2	Commander 24th Infantry Division and Fort Stewart ATTN: AFZP-DEV (Mr. Tim Harper) Fort Stewart, GA 31314
1	Commander U. S. Army Forces Command ATTN: AFPI-ENO (Mr. Naresh Kapur) Fort McPherson, GA 30330
2	Savannah District Corps of Engineers ATTN: CESAS-PM-MR (Mr. Rob Callahan) 100 W. Oglethorpe Avenue P. O. Box 889 Savannah, GA 31402-0889
1	Mobile District, Corps of Engineers ATTN: CESAM-EN-DM (Mr. Tony Battaglia) P. O. Box 2288 Mobile, AL 36628-0001

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: March 1, 1996

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: William T. Todd, PE Bill
Field Survey Manager

Subject: Weekly Field Survey Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following investigation progress was made on the subject project during the week ending 23 February 1996:

> Site visit was accomplished on February 21. The purpose of the site visit was to use ultrasonic leak detection equipment to locate leaks in selected sections of the underground HTW distribution piping. Ultrasonic leak detectors and a microprocessor - based leak correlation equipment were used in an attempt to pinpoint leaks in the HTW piping system between valve pits. Due to very loud background noise, the test results were inconclusive.

Additional field survey work planned:

> There are no additional field surveys planned for this project.

/kw

cc: T. Harper (FSEO)

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: March 1, 1996

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of February 1996:

1. A field investigation was performed on February 21. The goal was to use ultrasonic leak detection equipment to locate leaks in selected sections of the underground HTW distribution piping. The results were inconclusive due to very loud background noise in the HTW piping system.

2. Completed analysis of ECOs and submitted Interim Report.

Work planned for March 1996:

1. Await government review comments on the Interim Submittal.

2. Schedule review conference and presentation of Interim Report.

/kw

cc: T. Harper (FSEO)
W. Todd

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: April 4, 1996

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of March 1996:

No additional work was accomplished due to the Government review of the Interim Report.

Work planned for April 1996:

1. Await government review comments on the Interim Submittal.

2. Schedule review conference and presentation of Interim Report.

---

cc: W. Todd

FACSIMILE TRANSMITTAL HEADER SHEET

For use of this form, see AR 25-11; the proponent agency is ODISC4

COMMAND/ OFFICE	NAME/ OFFICE SYMBOL	OFFICE TELEPHONE NO. (AUTOVON/Comm.)	FAX NO. (AUTOVON/Comm.)
FROM: Savannah District	Rob Callahan CESAS-PM-MP	(912) 652-5246	(912) 652-5442
TO: R S & H	BILL TODD CARLOS WARREN		

CLASSIFICATION	PRECEDENCE	NO. PAGES (Including this Header)	DATE-TIME	MONTH	YEAR	RELEASER'S SIGNATURE
N/A		17	15	4	96	Robert R. Callahan

REMARKS Following are the comments I've received on the Fort Stewart EEAP study. See you Wednesday.

Space Below For Communications Center Use Only

DA FORM 3918-R, JUL 90 DA FORM 3918-R, AUG 72 IS OBSOLETE V2.00

RS&H

Memorandum

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Date: April 29, 1996

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, PhD, PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of April 1996:

1. The Interim Report Review Conference was held at Ft. Stewart on 17 April 1996. Project findings and subsequent evaluation of the HTW line repair ECO was presented by RS&H. Comments were discussed and disposition of each comment was agreed to by conference participants.

2. Schedule for pre-final report submittal is 31 May 1996, 44 days after the Interim Review Conference.

Work planned for May 1996:

1. Complete and submit the pre-final report.

---

cc: W. Todd

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Transmittal Letter

To: Attached Distribution List

Date: May 31, 1996

Project: Limited Energy Study HTW & CHW Distribution Sys. Fort Stewart & Hunter AAF

Project Number: 694-1331-002

We Transmit:

(X) Herewith ( ) Via Fax
( ) Under Separate Cover Via:
( ) In Accordance with Your Request
( ) Regular Mail (X) Overnight Mail ( ) Courier

For Your:

( ) Approval
(X) Review and Comment
( ) Use
( ) Signature

The Following:

Copies	Date	Description
As per distribution list	5-31-96	Vol. 1 Narrative Report-Pre-Final Submittal
As per distribution list	5-31-96	Vol. II Appendicies
As per distribution list	5-31-96	Vol. III Cover, Title Page and Table of Contents
As per distribution list	N/A	Vol. III Valve Pit Summary Sheets - Section 1
As per distribution list	N/A	Vol. III Mech. Room Summary Sheets - Section 2
As per distribution list	N/A	Vol. III Leak Dections Survey Forms - Section 4

Remarks:

/kw

Copies To: C. Warren
File

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491
FL Cert. Nos. AAC001886•EB0005620•LCC000210

By: William T. Todd
William T. Todd, PE

Limited Energy Study
HTW and CHW Distribution Systems
Fort Stewart and Hunter AAF

PRE-FINAL REPORT

No. Copies

2	Commander 3rd Infantry Division and Fort Stewart Attn: AFZP-DEV (Mr. Chet Scratzmeier) Fort Stewart, GA 31314
1	Commander U. S. Army Forces Command Attn: AFPI-ENO (Mr. Naresh Kapur) Fort McPherson, GA 30330
2	Savannah District Corps of Engineers Attn: CESAS-PM-MR (Mr. Rob Callahan) 100 W. Oglethorpe Avenue P. O. Box 889 Savannah, GA 31402-0889
1	Mobile District, Corps of Engineers Attn: CESAM-EN-DM (Mr. Tony Battaglia) 109 St. Joseph Street Mobile, AL 36602

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Memorandum

Date: June 5, 1996

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, Ph.D., PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of May 1996:

- The Prefinal Report was completed and submitted on 31 May.

Work planned for June 1996:

- None planned; awaiting comments on the Prefinal Report.

CC: W. Todd

F:\FTS\MAY_RPT.DOC

Memorandum

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Date: July 5, 1996

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, Ph.D., PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of June 1996:

- No work was done on the project, as it is in the review process.

Work planned for July 1996:

- None planned; awaiting comments on the Prefinal Report.

CC: W. Todd
A. Battaglia, Mobile COE

F:\FTS\JUN_RPT.DOC

Memorandum

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

Date: August 5, 1996

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, Ph.D., PE
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of July 1996:

- No work was done on the project, as it is in the review process.

Work planned for August 1996:

- None planned; awaiting comments on the Prefinal Report.

CC: W. Todd
A. Battaglia, Mobile COE

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FACSIMILE TRANSMITTAL HEADER SHEET

For use of this form, see AR 25-11; the proponent agency is ODISC4

	COMMAND/ OFFICE	NAME/ OFFICE SYMBOL	OFFICE TELEPHONE NO. (AUTOVON/Comm.)	FAX NO. (AUTOVON/Comm.)
FROM:	Savannah District	Rob Callahan CESAS-PM-MP	(912) 652-5246	(912) 652-5442
TO:	RS & H	BILL TODD		

CLASSIFICATION	PRECEDENCE	NO. PAGES (Including this Header)	DATE-TIME	MONTH	YEAR	RELEASER'S SIGNATURE
N/A		2	11	8	96	Robert A. Callahan

REMARKS Bill, following are ~~the~~ only comments I will be sending to you regarding the Ft. Stewart EEAP study. Please incorporate them into your final submittal. As a reminder, I'd like for you to re-read the "Specific Instructions" before you go final to

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DA FORM 3918-R, JUL 90 DA FORM 3918-R, AUG 72 IS OBSOLETE V2.00

insure compliance with all provisions. Thanks for your good work. Fred Cardo at Ft. Stewart is pleased with your work.

RAC

Memorandum

RS&H
Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

---

Date: September 4, 1996

To: Savannah District, Corps of Engineers
ATTN: CESAS-PM-MP (Mr. Rob Callahan)
P. O. Box 889
Savannah, GA 31402-0889

From: Carlos S. Warren, Ph.D., P.E.
Project Manager

Subject: Monthly Progress Report
Contract No. DACA01-94-0038/0002
Limited Energy Study - Hunter Army Airfield and Ft. Stewart HTW and CHW Distribution System

---

The following progress was made on the subject project during the month of August 1996:

- Comments on the Prefinal Report were received. The comments and responses were incorporated into the Final Report.

Work planned for September 1996:

- Completion of the Final Report.
- Submission of Final Report pages on September 6.

CC: W. Todd
A. Battaglia, Mobile COE

F:\FTS\AUG_RPT.DOC

RS&H

Transmittal Letter

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

To: Attached Distribution List

Date: September 6, 1996

Project: Limited Energy Study HTW & CHW Distribution Sys. Fort Stewart & Hunter AAF

Project Number: 694-1331-002

We Transmit:

(X) Herewith ( ) Via Fax
( ) Under Separate Cover Via:
( ) In Accordance with Your Request
( ) Regular Mail (X) Overnight Mail ( ) Courier

For Your:

( ) Approval
(X) Review and Comment
( ) Use
( ) Signature

The Following:

Copies	Date	Description
As per distribution list	9-6-96	Vol. 1-Insert and replacement pages
As per distribution list	9-6-96	Vol. II-Insert and replacement pages
As per distribution list	9-6-96	Vol. III-Insert and replacement pages
As per distribution list	9-6-96	Vol. ES-Executive Summary

Remarks:

/kw

Copies To: C. Warren
File

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256
(904) 296-2000 Fax: (904) 279-2491
FL Cert. Nos. AAC001886•EB0005620•LCC000210

By: William T. Todd
William T. Todd, PE

Limited Energy Study
HTW and CHW Distribution Systems
Fort Stewart and Hunter AAF

FINAL REPORT

No. Copies	
4	Commander 3rd Infantry Division and Fort Stewart Attn: AFZP-DEV (Mr. Fred Cavedo) Fort Stewart, GA 31314
1	Commander U. S. Army Forces Command Attn: AFPI-ENO (Mr. Naresh Kapur) Fort McPherson, GA 30330
2	Savannah District Corps of Engineers Attn: CESAS-PM-MR (Mr. Rob Callahan) 100 W. Oglethorpe Avenue P. O. Box 889 Savannah, GA 31402-0889
1	Mobile District, Corps of Engineers Attn: CESAM-EN-DM (Mr. Tony Battaglia) 109 St. Joseph Street Mobile, AL 36602
1 (ES only)	Commander U. S. Army Engineer Division, South Atlantic Attn: CESAD-EN-TE (Mr. Baggette) 77 Forsyth Street, SW Atlanta, GA 30335-6801
1 (ES only)	Commander U. S. Army Corps of Engineers Attn: CEMP-ET (Mr. Gentil) 20 Massachusetts Avenue, NW Washington, DC 20314-1000
1 (ES only)	Commander U. S. Army Logistics Evaluation Agency Attn: LOEA-PL (Mr. Keath) New Cumberland Army Depot New Cumberland, PA 17070-5007

A.10 RECORDS ANALYSIS AND SITE SURVEY PLAN

Limited Energy Study
High Temperature and Chilled Water Distribution Systems
Fort Stewart and Hunter AAF

Records Analysis and Site Survey Plan

August 28, 1995
Contract # DACA01-94-D-0038
Project # 694-1331-002

RS&H

Reynolds, Smith and Hills, Inc.
Architectural, Engineering, Planning and Environmental Services

A.10-1

Limited Energy Study
High Temperature and Chilled Water Distribution Systems

Fort Stewart and Hunter Army Airfield

Records Analysis and Site Survey Plan

Savannah District
Corps of Engineers

Contract No. DACA01-94-D-0038
Delivery Order #0002

Reynolds, Smith and Hills, Inc.
Jacksonville, Florida

Carlos S. Warren, PhD, PE
Project Manager

William T. Todd
William T. Todd, PE
Field Survey Manager

August 28, 1995

6941331002

A.10-2

RECORDS ANALYSIS AND
SITE SURVEY PLAN
FORT STEWART AND HUNTER ARMY AIRFIELD
HTW AND CHW DISTRIBUTION SYSTEMS

TABLE OF CONTENTS

RECORDS ANALYSIS AND SITE SURVEY PLAN
FORT STEWART AND HUNTER ARMY AIRFIELD
HTW AND CHW DISTRIBUTION SYSTEMS

1.0 RECOMMENDATIONS FOR THE HTW AND CHW SYSTEMS AT HUNTER AAF

1.1 HIGH TEMPERATURE WATER AND STEAM SYSTEMS

Estimated HTW System Losses

Makeup water volume data for the HTW and steam distribution systems for July 1994 through June 1995 were obtained from the Central Energy Plant (CEP) and Pinwheel Barracks Plant (PBP) operating logs. The total makeup water flow rate for this period was 333,857 gallons, or approximately 916 gallons per day (gpd). The PBP steam distribution system losses represent 77 percent (706 gpd) of the total and the CEP HTW system losses make up the remaining 23 percent (210 gpd). Assuming the blowdown is about equal to the chemical feed system input, the makeup water flow rate should be roughly equal to the amount of leaks from the distribution system. Based on an estimated total system volume of 1,900 gallons for the CEP HTW system, the estimated HTW leakage rate is approximately 11 percent of the total HTW system volume per day. The PBP distributes 50 psi steam. The losses from the PBP system are higher than the CEP system losses as would be expected for a steam distribution system.

The total estimated cost of losses from the CEP and PBP HTW distribution systems is approximately $2,120 per year. This value includes the cost for fuel oil used by the boilers (443 MBtu/Year & $1,925/Year); distribution system pumps (314 kWh/Year & $15/Year); and the cost of raw water produced at Hunter AAF ($180/Year). The cost for chemical treatment of the HTW system leaks is assumed to be negligible. The boiler energy use and cost assumes an average boiler efficiency of 75 percent.

Recommendations

The estimated 11 percent losses for the CEP distribution system are high for a closed loop system. However, the total costs of losses from the CEP HTW system and the PBP steam system are less than one percent of the total operating costs of these systems. Therefore, we recommend no further studies be undertaken for the HTW distribution systems from the CEP and the PBP.

1.2 CHILLED WATER DISTRIBUTION SYSTEMS

Estimated CHW System Losses

The chilled water makeup is not metered at either the CEP or the PBP. The Hunter AAF DPW staff said that their chilled water chemical treatment contractor has indicated a leakage problem with both the CEP and the PBP chilled water distribution systems. Conversations with the chemical treatment contractor revealed an estimate of thousands of gallons per week being lost form each of these two distribution systems and that there has been a leakage problem for over eight years. The contractor samples the CHW system water and adds chemicals each month. The chemicals have vanished between monthly samples. The actual CHW system losses cannot be accurately determined since there is no trace of the chemicals left.

The total chilled water system capacities were estimated to be about 4,700 gallons for the PBP and 4,200 gallons for the CEP. Assuming a conservative estimate of the equivalent of one system volume is lost each month, the CHW losses would amount to over 2,000 gallons per week. This represents a leakage rate of three percent of the total system volume per day. The actual losses could be much higher.

Recommendations

There is obviously a problem with these systems, however it can not be quantified without some type of metering effort. Installing new permanent water meters on the CHW system makeup water lines at the PBP and the CEP would cost approximately $500 and $200, respectively. The cost to have RS&H temporarily meter these systems would be much more than the $700 the Army would pay to have a mechanical contractor install the two new permanent meters.

We recommend that permanent flow meters be installed on the chilled water makeup lines at the CEP and the PBP. These meters should be read and the data tabulated on a monthly basis. The new information could be analyzed after three to four months of data have been observed and recorded. Recommendations for further action could be made at that time.

2.0 RECOMMENDATIONS FOR THE CHW SYSTEM AT FORT STEWART

Estimated CHW System Losses

Makeup water volume data for July 1994 through June 1995 for the chilled water distribution system were obtained from the CEP operating logs. The total makeup water flow rate for this period was 1,106,710 gallons, or approximately 3000 gallons per day. This makeup water flow rate should be roughly equal to the amount of chilled water leaks in the distribution system. The total volume of water in the CHW distribution system was estimated to be about 600,000 gallons. Based on the total estimated volume of chilled water, the estimated chilled water leakage is approximately 0.5 percent of the total chilled water system volume per day.

The total estimated cost of the chilled water system losses is about $1,250 per year. This value includes the cost for energy used by the chillers, condenser pumps and cooling tower fans (11,310 kWh/Year & $566/Year); distribution system pumps (1,310 kWh/Year & $66/Year); and the cost of raw water produced at Fort Stewart ($615/Year). There is no chemical treatment used for the chilled water distribution system. The chiller energy use and cost assumes all of the chilled water is produced by electric centrifugal chillers, a worst case scenario since electricity is the most expensive fuel utilized at Fort Stewart.

Recommendations

The amount of the CHW distribution system losses is less than one percent of the total CHW system volume per day. Therefore, we recommend no further studies be undertaken for the Fort Stewart CHW distribution system.

3.0 FORT STEWART HTW DISTRIBUTION SYSTEM

Estimated HTW System Losses

Makeup water volume data for July 1994 through June 1995 for the HTW distribution system were obtained from the Central Energy Plant (CEP) operating logs. The total metered makeup water flow for this period was 4,029,636 gallons, or approximately 11,048 gallons per day. Boiler blowdown and flow rates for the three unmetered chemical feed systems were estimated based on conversations with CEP operators. The total estimated losses for the HTW system are approximately 5,809,700 gallons per year. This estimate assumes the total makeup water less the boiler blowdown is roughly equal to the amount of leaks from the HTW distribution system. Based on an estimated total HTW system volume of 218,000 gallons, the estimated HTW leakage represents approximately five percent of the total HTW system volume per day. Typical closed loop distribution systems have a makeup requirement of one-fourth to one-half of one percent of the total system volume in a given 24 hour period.

The total estimated cost of losses from the HTW distribution system is $29,290 per year. This value includes the cost for wood chips, fuel oil and natural gas used by the boilers (22,100 MBtu/Year & $25,640/Year); distribution system pumps (8,400 kWh/Year & $420/Year); and the cost of raw water produced at Fort Stewart ($3,230/Year). The cost for chemical treatment of the HTW system leaks is assumed to be negligible compared to these other values. The calculated boiler energy use and cost assumes an average boiler efficiency of 68 percent.

4.0 FIELD INVESTIGATION PLAN

The field investigation will be accomplished in three phases. The objective of the first phase is to determine as accurately as possible how much is leaking from the HTW system. This will be accomplished by first surveying the Central Energy Plant and Satellite Energy Plants, and metering and estimating the mass flows into and out of the HTW system. The second step of the first phase is to estimate the amount of HTW leaking within the hot water generators in the buildings served by the HTW system.

Valve pits, drain pits and valve boxes will be inspected during the second phase of the field survey effort. This survey will indicate the location of leaking valves and fittings and also isolate sections of the underground distribution piping where leaks may be occurring. We will also attempt to quantify the amount of HTW leaking from the various valves and fittings.

The final phase of the field investigation will attempt to pinpoint and quantify the leaks within the underground HTW distribution system piping. The detailed field investigation plans and schedule of events are presented in the following pages.

4.1 CENTRAL ENERGY PLANT (CEP)

1. Measure the flow of makeup water to the HTW system.

   The amount of makeup water added to the HTW system is a direct indication of how much HTW is leaking out of the system.

   The flows will be measured using a non-intrusive, clamp-on, transient-time ultrasonic flow meter. If any pipe insulation must be removed for these measurements, we will request that the Fort Stewart DPW perform the removal and reinstallation.

   We will make sure the makeup water flow measurements include the water softeners, two chemical feed systems and the phosphate tank. It appears that the metered flow only includes the water that goes through the water softeners.

   There is a 3 inch raw water line that should include all of these systems except perhaps the phosphate tank. The 3 inch line splits with a 2.5 inch line going to the water softeners and two 3/4 inch lines going to the chemical feed systems. The 2.5 inch makeup water line from the

water softeners and the 3/4 inch makeup water line from the sulphur tank feed into the deaerator. The 3/4 inch makeup water line from the ph control tank feeds into all three cascade heaters.

There is a 1/2 inch line (rated at 5 g.p.m. on the record drawings) from the phosphate tank that feeds into the 4 inch feed water line to the wood fired boiler.

2. <u>Measure or estimate the continuous and intermittent blowdown from all boilers and cascade heaters.</u>

The amount of blowdown water must be subtracted from the amount of makeup water to determine the actual HTW distribution system losses.

The flows will be measured using a non-intrusive, clamp-on, transient-time ultrasonic flow meter. If any pipe insulation must be removed for these measurements, we will request that the Fort Stewart DPW perform the removal and reinstallation.

There is a 4 inch line from the intermittent blowdown tank (for the wood fired boiler) rated at 165 g.p.m. on the record drawings.

Each of the three cascade heaters has a 1.5 inch blowdown line that feeds into a 3 inch header. The 3 inch blowdown header goes to a blowdown tank that may or may not be the same tank mentioned above. The record drawings indicate a blowdown tank located outside the south corner of the CEP. It is not clear from the drawings but this line may be part of the condensate return system.

3. <u>Estimate the total flow of HTW through the supply distribution system.</u>

The total HTW flow value will be used to determine what percentage of the total flow is lost by leaks in the distribution system.

Read and record the pressures shown on the pressure gages before and after the supply pumps for all three HTW distribution zones. Measure and record the voltage and current for each HTW pump motor. Record the data from the nameplates on the pumps and pump motors.

4. <u>Obtain copies of the boiler water, boiler feed water and HTW supply water analysis reports.</u> These reports will be used to verify the boiler blowdown estimates and also to compare with the samples taken from the various domestic hot water systems in the buildings served by the HTW system. The comparison will help determine if any of the heat exchangers in the hot water generators have failed. Refer to section on survey of mechanical equipment rooms for additional information.

   We will also comment on the chemical makeup of the HTW system water and weather it is appropriate to prevent corrosion or pitting of the HTW distribution system piping.

Personnel Assignments

1 - Engineer

1 - Metering Subcontractor

4.2 SATELLITE ENERGY PLANT (SEP)

1. Measure or estimate the flow of makeup water to the SEP HTW distribution system.

The amount of makeup water added to the SEP HTW system will provide a direct indication of how much HTW is leaking out of this part of the system.

There is no direct fresh or treated makeup water feed to the SEP HTW distribution system. The water level in the two SEP cascade heaters is manually checked three times per day (once each shift). When the water level in the cascade heaters drops below a certain value, the CEP operators use the HTW system return pipes to "back fill" the SEP cascade heaters. We will determine how often these systems need to be filled and approximately how much water is "added".

2. Measure or estimate the blowdown from the two cascade heaters.

The amount of blowdown water must be subtracted from the amount of makeup water to determine the actual HTW distribution system losses.

Each of the three cascade heaters in the CEP has a 1.5 inch blowdown line. Assuming the two cascade heaters in the SEP also have blowdown lines, we will determine the frequency and duration of use for these blowdown lines.

3. Estimate the total flow of HTW through the SEP supply distribution system.

The total HTW flow from the SEP will be used to determine what percentage of the total HTW flow is lost by leaks in this distribution system.

Read and record the pressures shown on the pressure gages before and after the supply pump. Measure and record the voltage and current for the HTW pump motor. Record the data from the nameplates on the pumps and pump motors.

Personnel Assignments

1 - Engineer

1 - Metering Subcontractor

4.3 BUILDING HOT WATER GENERATORS

1. Obtain a sample of the domestic hot water from the building for testing.

   These samples will be analyzed by a laboratory and the analysis will be compared to the analysis of the HTW and the Fort Stewart potable water supply. If chemicals that are usually only present in the HTW are found in the domestic hot water, then the heat exchanger has probably failed and is leaking. Hot water temperatures will also be measured to indicate a leaking heat exchanger or failed controls/valves.

   The domestic hot water source will be allowed to flow for a sufficient time prior to sampling to ensure the sample is not diluted with potable cold water. The samples will be taken during a time that the building hot water system is not being heavily used (9:00 AM to 3:00 PM).

2. Survey Hot Water Generators.

   Those hot water generators that have leaking HTW heat exchangers will be surveyed to determine the leakage rate and volume. The hot water generators will be isolated by cut-off valves and tank overflows measured.

Personnel Assignments

Crew No. 1:	Crew No. 2:
1 - Engineer	1 - Engineer
1 - Technician	1 - Technician

4.4 VALVE PITS, DRAIN PITS AND VALVE BOXES

Valve Pits

There are approximately 60 valve pits located along the HTW supply and return lines.

1. Check for HTW leaks around the valve stems, flanges and fittings for all of the valves and fittings in the valve pit. Estimate the volume of flow from each leak found.

   Valves and fittings typically found in the valve pits are listed below.

   a. Check globe valves on all HTW mains and take offs.

   b. Check drain valves on all mains. There are two globe valves for each HTW main valve.

   c. Check valves and fittings on all line vents. There are two globe valves and an air bottle on each vent line.

2. Check for steam flowing from the conduit vents on HTW lines where they enter and exit the pit.

3. If there is standing water in the bottom of the pit, make a note indicating that the pump is not working.

Drain Pits

The drain pits are located at low points along the main HTW supply and return lines.

1. Check for HTW leaks around the valve stems, flanges and fittings for all of the valves and fittings in the drain pits. Estimate the volume of flow from each leak found.

   Typically, there is one globe valve on each HTW supply and return line.

2. Check for steam flowing from the conduit vents on HTW lines where they enter and exit the pit.

3. If there is standing water in the bottom of the pit, make a note indicating that the pump is not working.

Valve Boxes

The valve boxes are located at high points along the main HTW supply and return lines.

1. Check for HTW leaks around the valve stems, flanges and fittings for all of the valves and fittings in the valve boxes. Estimate the volume of flow from each leak found.

   There are typically two HTW risers in each valve box and two globe valves and one air bottle on each riser.

Personnel Assignments

Crew No. 1:	Crew No. 2:
1 - Engineer	1 - Engineer
1 - Technician	1 - Technician

4.5 UNDERGROUND HTW DISTRIBUTION SYSTEM PIPING

Information obtained during the survey of the valve pits will be used to isolate sections of the HTW distribution system that is suspected of having leaks. Once these sections of piping have been identified, an infrared thermometer will be used to locate "hot spots" at ground level along the HTW distribution piping. The hot spots will indicate areas of the piping where the pipe insulation has become saturated and is no longer effective. There are two possible causes of the hot spots. Either the outer conduit has failed and the insulation has become soaked with groundwater, or a leak in the pipe has caused the insulation to become saturated with HTW.

The sections of HTW piping suspected of having leaks will be systematically surveyed with a electronic gas and liquid leak detector in an effort to determine as accurately as possible the location of all distribution system leaks. The leaking HTW will more than likely flash to steam as it escapes from the pipe. The ultrasonic range of the leak detector will be used to locate these gaseous type "steam" leaks. The sonic range can be used to detect liquid leaks if for some reason the HTW leaks remain in the liquid form.

Personnel Assignments

Crew No. 1:

1 - Engineer

1 - Technician

Crew No. 2:

1 - Engineer

1 - Technician

5.0 SCHEDULE OF EVENTS

Week Ending	Tasks to be Accomplished
Aug 04, 1995	- Obtain data, drawings and maintenance records for the HTW and CHW systems at Fort Stewart and Hunter AAF. - Conduct interviews with DPW Personnel at Fort Stewart and Hunter AAF. - Preliminary survey of CEP, valve pits and mechanical equipment rooms at Fort Stewart.
Sep 15, 1995	- Locate HTW makeup water, chemical feed and blowdown pipes to be metered and determine if pipe insulation removal is required. - Obtain copies of recent HTW sample analysis reports from the CEP and potable water analysis reports from the water plant. - Progress report to FESO and Savannah COE.
Oct 27, 1995	- Survey the CEP. Meter HTW makeup water, chemical feed water and blowdown water. Record pump and motor data. - Survey the SEP. Meter HTW makeup water and blowdown water. Record pump and motor data. - Water samples taken in buildings. - Progress report to FESO and Savannah COE.
Nov 10, 1995	- Survey valve pits, drain pits and valve boxes. - Progress report to FESO and Savannah COE.
Dec 15, 1995	- Survey HTW supply and return distribution lines. - Survey leaking hot water generators. - Progress report to FESO and Savannah COE.

6.0 SUPPORTING DATA AND CALCULATIONS

RS&H

SUBJECT	HUNTER AAF HTW DIST. SYSTEM	AEP NO	
		SHEET	1 OF 2
DESIGNER	WTT	DATE	8-16-95
CHECKER		DATE	

HTW System Losses

Make up water data for the Pinwheel Barracks and the central energy plant were tabulated from boiler logs for 7/94 through 6/95. Assuming the make up water is equal to the distribution system losses less the amount of boiler blowdown, the

Make up Water	916	gal/day	(avg)
Chemical Feed	+ 30	gal/day	estimate
Blowdown	− 30	gal/day	estimate
System Losses =	916	gal/day	(avg)
	0.6	gal/min	(avg)

Energy Loss :

$$257{,}332 \ \text{gal/yr} \times 8.345 \frac{\text{lb}}{\text{gal}} \times 1 \frac{\text{Btu}}{\text{lb}\,^\circ\text{F}} \times (155-70)\,^\circ\text{F} = 182.5 \frac{\text{MBtu}}{\text{YR}} \quad \text{(PB)}$$

$$76{,}525 \ \text{''} \times \text{''} \times \text{''} \times (305-70)\,^\circ\text{F} = 150.1 \frac{\text{MBtu}}{\text{YR}} \quad \text{(CEP)}$$

$$\text{Total Energy Loss} = 182.5 + 150.1 = \underline{332.6 \ \text{MBtu/YR}}$$

$$\text{Cost}: \ \$0.6124/\text{gallon} \times \frac{1 \ \text{gallon}}{0.141 \ \text{MBtu}} = \$4.34/\text{MBtu}$$

$$332.6 \frac{\text{MBtu}}{\text{YR}} \times \frac{1}{0.75} \text{eff} \times \$4.34/\text{MBtu} = \underline{\$1{,}925/\text{Year}}$$

Pumping Cost

$$\text{Pump BHP} = \frac{\text{GPM} \times \text{Head}}{3960 \times \text{eff}} = \frac{0.6 \times 200\,\text{ft}^{*}}{3960 \times 0.70} = 0.04 \ \text{BHP}$$

* From record drawings

Pumping cost - continued

$$0.04\ BHP \times 0.746\ \frac{KW}{HP} \div 0.9\ \substack{\text{motor}\\ \text{eff}} \times 8760\ \frac{hr}{yr} = \underline{314\ \frac{kwh}{yr}}$$

$$\text{Cost} = 314\ \frac{kwh}{yr} \times \$0.048/kwh = \underline{\$15/year}$$

Water Cost

$$886\ \frac{gal}{day} \times 365\ \frac{day}{yr} \times \$0.56/1000\ gal = \underline{\$181/year}$$

Total Cost

Heating Fuel + Pumping cost + Water cost = Total

$$\text{Total Cost} = \$1925 + \$15 + \$180 \approx \underline{\$2{,}120/year}$$

Percent Losses (CEP only)

$$\frac{210\ gal/day\ makeup}{1900\ gallons\ volume} \times 100 = \underline{\underline{11\%}}$$

Hunter AAF - Central Energy Plant & Pinwheel Barracks
Boiler Makeup Water
Filename: HAAF-HTW.WQ1

Mo	Yr	PB (2) Makeup Gal(1)	Makeup Gal/Day	CEP (3) Makeup Gal(1)	Makeup Gal/Day	Total Makeup Gal(1)	Makeup Gal/Day
7	94	18660	602	4010	129	22670	731
8	94	17320	559	3640	117	20960	676
9	94	15030	501	3320	111	18350	612
10	94	15460	499	7478	241	22938	740
11	94	18870	629	10950	365	29820	994
12	94	17950	579	10310	333	28260	912
1	95	23840	769	6900	223	30740	992
2	95	23499	839	5730	205	29229	1044
3	95	26440	853	5750	185	32190	1038
4	95	23750	792	6280	209	30030	1001
5	95	28873	931	6222	201	35095	1132
6	95	27640	921	5935	198	33575	1119
AVG		21444	706	6377	210	27821	916
TOTALS		257332		76525		333857	

(1) Source is Hunter AAF Operating Logs.
(2) PB - Pinwheel Barracks Energy Plant.
(3) CEP - Central Energy Plant.

Estimate Distribution System Losses:

	916	gpd, avg make-up water
-	30	gpd, avg blowdown water *
	886	gpd, avg dist sys losses

* Boiler blowdown estimate:

	300	gpm, estimate 150 gpm for 3 inch pipe x 2 pipes
x	0.033	min/blowdown, 2 seconds per blowdown
	10	gal/blowdown
x	3	blowdowns/day, assumed 3 blowdowns per day
	30	gal/day

Hunter AAF - Central Energy Plant
Estimate of HTW System Losses
Filename: H-HTW-CP.WQ1

Pipe Service	Bldg. Served	Pipe Dia. (in)	Linear Feet	Pipe Vol. (CF)	Pipe Vol. (Gal)
CWS	All (Plant)	6	150	29.5	220
CWR	All (Plant)	6	200	39.3	294
CWS	All (main)	6	26	5.1	38
CWR	All (main)	6	26	5.1	38
CWS	All (main)	4	255	22.3	166
CWR	All (main)	4	255	22.3	166
CWS	All (main)	2	368	8.0	60
CWR	All (main)	2	368	8.0	60
CWS	1-S Bldg.	1	154	0.8	6
CWR	1-S Bldg.	1	154	0.8	6
CWS	2-S Bldg.	1	98	0.5	4
CWR	2-S Bldg.	1	98	0.5	4
TOTALS			2152		1062

Expansion Tanks, etc	500	
Two Story Building Piping (estimate)	200	
One Story Building Piping (estimate)	125	
Estimated System Volume	1887	Gallons

1.0% of total volume lost per day =	19	Gal/Day
19 gal/day x 30 day/mo =	566	Gal/Mo.
19 gpd / 1440 min/day =	0.01	Gal/Min
100.0% of total volume lost per day =	1887	Gal/Day
1887 gal/day x 30 day/mo =	56610	Gal/Mo.
1887 gpd / 1440 min/day =	1.31	Gal/Min

Hunter Army Air Field
Fuel Oil Consumption
Filename: HAAF-OIL.WQ1

Month	CEP	PBP	Total
Jul	3730	21157	24887
Aug	3880	17978	21858
Sep	3460	17244	20704
Oct	5454	8611	14065
Nov	6421	13004	19425
Dec	10040	28962	39002
Jan	8470	43829	52299
Feb	8455	44122	52577
Mar	6630	44965	51595
Apr	5379	29115	34494
May	4580	21693	26273
Jun	3850	23250	27100
Gal/Yr	70349	313930	384279
Mbtu/Y	9919	44264	54183
$/Yr	43082	192251	235332

RS&H®

Telephone Call Confirmation

912-352-5519

Project Number 694 1331 002

Local ______ L.D. ______ Placed ______ Rec'd ______ Date 8-17-95

Conversed with Troy Noonan Of Hunter AAF Boiler Plants

Regarding Blowdown estimate for CEP and PB boilers

They have no set schedule for boiler blowdown. The operator that samples the water will manually blowdown the boiler as needed to adjust the chemical makeup of the water.

The blowdown pipe is approximately 3 inches in diameter. The duration of each blowdown is 2 seconds.

Distribution:

RS&H

SUBJECT HUNTER AAF
CHW DIST. SYSTEM
DESIGNER WTT
CHECKER

AEP NO
SHEET 1 OF
DATE 8-22-95
DATE

According to the chemical treatment contractor, at least one complete volume must be leaking out each month.

CEP Volume ≈ 4150 gal.
PBP Volume ≈ 4670 gal.

Total = 8,820 gal.

8,820 gal / 30 days ≈ 294 gal/day

$$\text{Percent losses} \approx \frac{294\ \frac{\text{gal}}{\text{day}}\ \text{makeup est.}}{8{,}820\ \text{gal Volume est.}} \times 100 = \underline{3\%\ \text{minimum}}$$

RS&H

SUBJECT	HUNTER AAF CHW DIST. SYSTEM	AEP NO	
		SHEET	2 OF
DESIGNER	WTT	DATE	8-21-95
CHECKER		DATE	

SYSTEM INFORMATION :

PBP; From record drawings, Chiller cap = 600 tons

1060 gpm, 90 ft head, 80% eff.

Pump motor design = 40 hp

$$\text{Pump BHP} = \frac{1060 \times 90}{3960 \times 0.8} = 30 \text{ BHP}$$

Make up water pipe dia. = 1", meter cost ≈ $200

CEP; from record drawings, Chiller cap. = 200 tons

342 gpm, 45 ft head, 78% eff.

Pump motor design = 20 hp

$$\text{Pump BHP} = \frac{342 \times 45}{3960 \times 0.78} = 5 \text{ BHP}$$

Makeup water pipe dia. = 1½", meter cost ≈ $500

Hunter AAF - Central Energy Plant
Estimate of Chilled Water Losses
Filename: H-CHW-CP.WQ1

Pipe Service	Bldg. Served	Pipe Dia. (in)	Linear Feet	Pipe Vol. (CF)	Pipe Vol. (Gal)
CWS	All (Plant)	8	145	50.6	379
CWR	All (Plant)	8	90	31.4	235
CWS	All (main)	8	285	99.5	744
CWR	All (main)	8	285	99.5	744
CWS	All (main)	6	338	66.4	496
CWR	All (main)	6	338	66.4	496
CWS	1-S Bldg.	4	154	13.4	101
CWR	1-S Bldg.	4	154	13.4	101
CWS	2-S Bldg.	3	98	4.8	36
CWR	2-S Bldg.	3	98	4.8	36
TOTALS			1985		3368

Expansion Tank	132	
Two Story Building Piping (estimate)	400	
One Story Building Piping (estimate)	250	
Estimated System Volume	4150	Gallons

1.0% of total volume lost per day = 42 Gal/Day

42 gal/day x 30 day/mo = 1245 Gal/Mo.

42 gpd / 1440 min/day = 0.03 Gal/Min

100.0% of total volume lost per day = 4150 Gal/Day

4150 gal/day x 30 day/mo = 124500 Gal/Mo.

4150 gpd / 1440 min/day = 2.88 Gal/Min

Hunter AAF - Pinwheel Barracks Chiller Plant
Estimate of Chilled Water Losses
Filename: H-CHW-PB.WQ1

Pipe Service	Bldg. Served	Pipe Dia. (in)	Linear Feet	Pipe Vol. (CF)	Pipe Vol. (Gal)
CWS	All (Plant)	8	67	23.4	175
CWR	All (Plant)	8	85	29.7	222
CWS	All (main)	8	218	76.1	569
CWR	All (main)	8	218	76.1	569
CWS	1275	6	308	60.5	452
CWR	1275	6	308	60.5	452
CWS	1276	4	274	23.9	179
CWR	1276	4	274	23.9	179
CWS	1277	6	304	59.7	447
CWR	1277	6	304	59.7	447
TOTALS			2360		3691

Expansion Tank	80	
Building 1275 Piping (estimate)	300	
Building 1276 Piping (estimate)	300	
Building 1277 Piping (estimate)	300	
Estimated System Volume	4671	Gallons

1.0% of volume lost per day =	47	Gal/Day
47 gal/day x 30 day/mo =	1401	Gal/Mo.
47 gpd / 1440 min/day =	0.03	Gal/Min
100.0% of volume lost per day =	4671	Gal/Day
4671 gal/day x 30 day/mo =	140130	Gal/Mo.
4671 gpd / 1440 min/day =	3.24	Gal/Min

RS&H®

Telephone Call Confirmation

800-343-0538

Project Number 694 1331 002

Local ______ (L.D.) Atlanta (Placed) ______ Rec'd ______ Date 8-17-95

Conversed with Frank Lloyd Of Technical Specialties Corp.

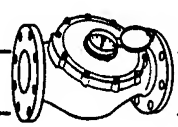
Regarding Hunter AAF Chilled Water Systems at CEP & PB

Frank estimates "thousands of gallons per week" are lost from each chilled water system. They add chemicals to the systems and when a sample is taken the following month there is no trace of the chemicals. They can estimate the volume lost by taking samples more often and tracking the chemical depletion. Frank estimates the cost of installing a new permanent water meter is between \$200 (for a 1" pipe) and \$600 (for a 3" pipe). He called the water leaks in the CEP and PB a "serious loss". In addition to the costs of leaks, the loss of chemicals creates a corrosion problem. These systems have been leaking for over 8 years. The volume in a system is estimated at 7-9 gallons/ton. Cost for chemical treatment is \$4-\$6 per ton (for systems > 1000 tons).

Distribution:

153 100 | Water Appliances

			Crew	Daily Output	Man-Hours	Unit	1995 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P	
130	3060	140 gal., 24" diam. x 80" LOA	1 Plum	6	1.333	Ea.	2,125	39		2,164	2,375	130
	3080	225 gal., 30" diam. x 78" LOA		4	2		2,050	58.50		2,108.50	2,350	
	3100	325 gal., 36" diam. x 81" LOA		3	2.667		2,500	78		2,578	2,875	
	3120	460 gal., 42" diam. x 84" LOA	Q-1	4	4		3,450	106		3,556	3,950	
	3140	605 gal., 48" diam. x 87" LOA		3	5.333		4,775	141		4,916	5,475	
	3160	740 gal., 54" diam. x 91" LOA		3	5.333		5,700	141		5,841	6,500	
	3180	940 gal., 60" diam. x 93" LOA		2.50	6.400		6,550	169		6,719	7,450	
	3200	1330 gal., 66" diam. x 107" LOA		2	8		8,750	211		8,961	9,950	
	3220	1615 gal., 72" diam. x 110" LOA		1.50	10.667		10,100	281		10,381	11,500	
	3240	2285 gal., 84" diam. x 128" LOA		1	16		15,100	420		15,520	17,200	
	3260	3440 gal., 96" diam. x 157" LOA	Q-2	1.50	16		22,400	440		22,840	25,300	
160	0010	WATER SUPPLY METERS										160
	1000	Detector, serves dual systems such as fire and domestic or										
	1020	process water, wide range cap., UL and FM approved										
	1100	3" mainline x 2" by-pass, 400 GPM	Q-1	3.60	4.444	Ea.	5,825	117		5,942	6,600	
	1140	4" mainline x 2" by-pass, 700 GPM	"	2.50	6.400		6,275	169		6,444	7,150	
	1180	6" mainline x 3" by-pass, 1600 GPM	Q-2	2.60	9.231		8,525	252		8,777	9,750	
	1220	8" mainline x 4" by-pass, 2800 GPM		2.10	11.429		12,900	315		13,215	14,700	
	1260	10" mainline x 6" by-pass, 4400 GPM		2	12		21,000	330		21,330	23,600	
	1300	10"x12" mainlines x 6" by-pass,5400 GPM		1.70	14.118		21,900	385		22,285	24,600	
	2000	Domestic/commercial, bronze										
	2020	Threaded										
	2060	5/8" diameter, to 20 GPM	1 Plum	16	.500	Ea.	66.50	14.65		81.15	96	
	2080	3/4" diameter, to 30 GPM		14	.571		115	16.75		131.75	153	
	2100	1" diameter, to 50 GPM		12	.667		157	19.55		176.55	202	
	2300	Threaded/flanged										
	2340	1-1/2" diameter, to 100 GPM	1 Plum	8	1	Ea.	420	29.50		449.50	505	
	2360	2" diameter, to 160 GPM	"	6	1.333	"	615	39		654	735	
	2600	Flanged, compound										
	2640	3" diameter, 320 GPM	Q-1	3	5.333	Ea.	2,900	141		3,041	3,425	
	2660	4" diameter, to 500 GPM		1.50	10.667		4,525	281		4,806	5,400	
	2680	6" diameter, to 1,000 GPM		1	16		6,500	420		6,920	7,825	
	2700	8" diameter, to 1,800 GPM		.80	20		12,800	530		13,330	14,900	
	7000	Turbine										
	7260	Flanged										
	7300	2" diameter, to 160 GPM	1 Plum	7	1.143	Ea.	790	33.50		823.50	920	
	7320	3" diameter, to 450 GPM	Q-1	3.60	4.444		1,125	117		1,242	1,425	
	7340	4" diameter, to 650 GPM	"	2.50	6.400		1,950	169		2,119	2,400	
	7360	6" diameter, to 1800 GPM	Q-2	2.60	9.231		3,250	252		3,502	3,950	
	7380	8" diameter, to 2500 GPM		2.10	11.429		6,925	315		7,240	8,100	
	7400	10" diameter, to 5500 GPM		1.70	14.118		9,475	385		9,860	11,000	



155 | Heating

155 100 | Boilers

			Crew	Daily Output	Man-Hours	Unit	1995 Bare Costs Mat.	Labor	Equip.	Total	Total Incl O&P	
101	0010	AVERAGE Square foot and percent of total										101
	0020	job cost, see division 171										
105	0010	BOILERS, GENERAL Prices do not include flue piping, elec. wiring,										105
	0020	gas or oil piping, boiler base, pad, or tankless unless noted										

15 MECHANI

A-10-29

RS&H

SUBJECT	FORT STEWART CHILLED WATER SYSTEM	AEP NO	
		SHEET	1 OF 3
DESIGNER	W.T.T.	DATE	8-16-95
CHECKER		DATE	

Chilled water makeup:

from operator logs for 7/94 - 6/95 the total amount of make up water for the chilled water distribution system = 1,106,710 gal/yr.

Averge make up ≈ 3000 gal/day

Average makeup = 2.1 gal/min

This amount should be approximately equal to the amount of leaks in the distribution system, and is much less than 1% of the total chilled water supplied to the distribution system.

Energy Loss:

$$1106710 \frac{gal}{Yr} \times \frac{8.345\ lb}{gal} \times 1 \frac{Btu}{lb\ °F} \times (70-49)°F = 193.9 \frac{MBtu}{YR}$$

Assuming all electric chillers (worst case):

$$193.9 \frac{mBtu}{YR} \times 0.70 \frac{kw}{ton} \times \frac{1\ ton}{12000\ Btu} = 11,310\ kwh/YR$$

$$Cost = 11,310\ kwh/yr \times \$0.0500/kwh = \$566/YR$$

Pumping Cost:

$$Pump\ BHP = \frac{GPM \times Head}{3960 \times eff} = \frac{2.1 \times 250^{*}}{3960 \times 0.72} = 0.18\ BHP$$

$$0.18\ BHP \times 0.746 \frac{KW}{HP} \div 0.9\ motor\ eff. \times 8760\ hr/yr = 1310\ kwh/yr$$

A.10-30

* from record drawings

Pumping Cost = 1310 kWh/yr × $0.0500/kWh = $66 /YR

Water Cost:

$$1{,}106{,}710 \ \frac{\text{gal}}{\text{yr}} \times \frac{\$0.5562}{1000 \text{ gal}} = \$615/\text{YR}$$

Total Cost

Energy Cost + Pumping cost + Water Cost = Total

Total Cost = $ 566 + $ 66 + $ 615 = $ 1247/YR

Percent Losses

$$\frac{3023 \ \frac{\text{Gal}}{\text{day}} \text{ Makeup}}{601184 \text{ Gal. Volume}} \times 100 = 0.5\%$$

RS&H

SUBJECT FORT STEWART
CHILLED WATER SYSTEM
DESIGNER WTT
CHECKER

AEP NO

DATE 8-16-95
DATE

Energy Required to Produce Chilled Water:

- Chiller : Assume 1994-95 model centrifugal chiller.

  Energy demand = 0.60 kw/ton

- Condenser Pumps :

  Assume: 3 gpm/ton (standard)
  Pump head = 60 ft, eff. = 0.72

  $$\frac{3 \frac{gpm}{ton} \times 60 \text{ ft}}{3960 \times 0.72} = 0.06 \text{ BHP/ton}$$

  $$0.06 \frac{BHP}{ton} \times 0.746 \frac{KW}{BHP} \div 0.9 \text{ motor eff.} = 0.05 \text{ kw/ton}$$

- Cooling Tower Fans :

  Assume : 100 hp for 1500 ton chiller (BAC catalog)
  85% motor loading, 90% motor eff.

  $$\frac{100 \text{ hp} \times 0.85}{1500 \text{ tons}} \times 0.746 \frac{kw}{BHP} \div 0.9 = 0.05 \text{ kw/ton}$$

- Total Energy Demand = 0.60 + 0.05 + 0.05 = 0.70 kw/ton

Fort Stewart Central Energy Plant
Chiller Makeup Water
Filename: FS-CHW.WQ1

Month	Year	Chiller Makeup Gal (1)	Days/ Month	Makeup Gal/Day	Chiller Makeup Gal/Min
7	94	210400	31	6787	4.7
8	94	131600	31	4245	2.9
9	94	83830	30	2794	1.9
10	94	76360	31	2463	1.7
11	94	290300	30	9677	6.7
12	94	58000	31	1871	1.3
1	95	18470	31	596	0.4
2	95	10310	28	368	0.3
3	95	25500	31	823	0.6
4	95	90810	30	3027	2.1
5	95	69570	31	2244	1.6
6	95	41560	30	1385	1.0
AVERAGES		92226		3023	2.1

TOTAL 1106710 gal/yr

(1) Source is Fort Stewart Operating Logs.

Estimate of Distribution System Losses:

2.1 gpm, avg make-up water

Fort Stewart - Central Energy Plant
Estimate of CHW System Losses
Filename: F-CHW-CP.WQ1

Pipe Service	Bldg. Served	Pipe Dia. (in)	Linear Feet	Pipe Vol. (CF)	Pipe Vol. (Gal)
ZONE 1					
CWS	All (main)	18	1350	2385.6	17847
CWR	All (main)	18	1350	2385.6	17847
CWS	All (main)	16	2000	2792.5	20891
CWR	All (main)	16	2000	2792.5	20891
CWS	All (main)	14	200	213.8	1599
CWR	All (main)	14	200	213.8	1599
CWS	All (main)	12	1850	1453.0	10870
CWR	All (main)	12	1850	1453.0	10870
CWS	All (main)	10	750	409.1	3060
CWR	All (main)	10	750	409.1	3060
CWS	All (main)	8	750	261.8	1959
CWR	All (main)	8	750	261.8	1959
CWS	All (main)	5	800	109.1	816
CWR	All (main)	5	800	109.1	816
CWS	All (main)	10	350	190.9	1428
CWR	All (main)	10	350	190.9	1428
CWS	All (main)	8	800	279.3	2089
CWR	All (main)	8	800	279.3	2089
CWS	All (main)	6	400	78.5	588
CWR	All (main)	6	400	78.5	588
Branch Piping (assume 5% of mains)					6115
60 Buildings Piping (estimate)					12000
SUBTOTAL ZONE 1			16100		140409
ZONE 2					
CWS	All (main)	14	3700	3955.4	29590
CWR	All (main)	14	3700	3955.4	29590
CWS	All (main)	10	1250	681.8	5100
CWR	All (main)	10	1250	681.8	5100
CWS	All (main)	8	500	174.5	1306
CWR	All (main)	8	500	174.5	1306
Branch Piping (assume 5% of mains)					3600
22 Buildings Piping (estimate)					4400
SUBTOTAL ZONE 2					79992

ZONE 3

CWS	All (main)	24	4750	14922.6	111638
CWR	All (main)	24	4750	14922.6	111638
CWS	All (main)	18	3500	6185.0	46271
CWR	All (main)	18	3500	6185.0	46271
CWS	All (main)	12	900	706.9	5288
CWR	All (main)	12	900	706.9	5288
CWS	All (main)	16	550	767.9	5745
CWR	All (main)	16	550	767.9	5745
CWS	All (main)	14	550	588.0	4399
CWR	All (main)	14	550	588.0	4399
CWS	All (main)	10	1000	545.4	4080
CWR	All (main)	10	1000	545.4	4080
Branch Piping (assume 5% of mains)					17742
16 Buildings Piping (estimate)					3200
SUBTOTAL ZONE 3			22500		375784

Plant, Expansion Tanks, etc 5000

Total Estimated System Volume 601184 Gallons

1.0% of total volume lost per day = 6012 Gal/Day

6012 gal/day x 30 day/mo = 180355 Gal/Mo.

6012 gpd / 1440 min/day = 4.17 Gal/Min

100.0% of total volume lost per day = 601184 Gal/Day

601184 gal/day x 30 day/mo = 18035532 Gal/Mo.

601184 gpd / 1440 min/day = 417 Gal/Min

Repair History & Cost for the CHW Distribution System
Fort Stewart, GA
Filename: FSREPAIR.WQ1

Chilled Water System		
Date	Labor Hrs	Cost
10-17-94	3.4	$92
10-19-94	11.0	$304
10-19-94	5.0	$135
12-09-94	2.9	$79
12-09-94	2.8	$76
3 MONTH	25.1	$686
	x 4	x 4
	------	------
TOTALS	100.4	$2,742

RS&H

SUBJECT FORT STEWART
HTW DIST. SYSTEM
DESIGNER WTT
CHECKER

AEP NO
SHEET 1 OF
DATE 8-17-95
DATE

Estimate of HTW System Losses

The metered flow of makeup water for the HTW system was obtained from operating logs for 7/94 through 6/95. Flows for the three chemical treatment system were estimated based on conversations with CEP personnel. The total makeup water less the estimated boiler blowdown is the total system losses.

HTW System Losses = 15917 gal/day

$$15917 \times 365 = 5{,}809{,}705 \text{ gal/year}$$

$$15917 \div 24 \div 60 = 11 \text{ gal/min}$$

Energy Losses

$$5809705 \frac{\text{gal}}{\text{yr}} \times 8.345 \frac{\text{lb}}{\text{gal}} \times 1 \frac{\text{Btu}}{\text{lb}\,^\circ\text{F}} \times (380-70)\,^\circ\text{F} = 15029 \frac{\text{mBtu}}{\text{YR}}$$

$$\text{Fuel use} = 15029 \frac{\text{mBtu}}{\text{yr}} \div 0.68 \text{ boiler eff.} = \underline{22{,}100 \frac{\text{mBtu}}{\text{YR}}}$$

$$\text{Fuel cost} = 22{,}100 \frac{\text{mBtu}}{\text{YR}} \times \$1.16/\text{mBtu} = \underline{\$25{,}640/\text{YR}}$$

Pumping Cost

$$\text{Pump BHP} = \frac{\text{GPM} \times \text{Head}}{3960 \times \text{eff}} = \frac{11 \times 300^*}{3960 \times 0.72^*} = 1.16 \text{ BHP}$$

* Data from record drawings

Pumping cost - continued.

$$1.16 \text{ BHP} \times 0.746 \frac{\text{KW}}{\text{HP}} \div 0.90 \ {}^{\text{motor}}_{\text{eff}} \times 8760 \frac{\text{hr}}{\text{YR}} = \underline{8404 \frac{\text{Kwh}}{\text{YR}}}$$

$$\text{Cost} = 8400 \ {}^{\text{Kwh}}/_{\text{yr}} \times \$\,0.0500/\text{Kwh} = \underline{\$420/\text{YR}}$$

Water Cost

$$5809705 \frac{\text{gal}}{\text{YR}} \times \frac{\$0.5562}{1000 \text{ gal}} = \underline{\$3{,}230/\text{year}}$$

Total Cost

Total = Energy Cost + Pumping Cost + Water Cost

Total Cost = $25,640 + $420 + $3,230 = $29,290 /YR

Fort Stewart Central Energy Plant
Boiler Makeup Water
Filename: FS-HTW1.WQ1

Month	Year	WS Makeup Gal(1)	Days/ Month	Makeup Gal/Day	S Makeup Gal/Day	M Makeup Gal/Day	P Makeup Gal/Day	Total Makeup Gal/Day
7	94	535250	31	17266	72	72	7200	24610
8	94	407100	31	13132	72	72	7200	20476
9	94	246220	30	8207	72	72	7200	15551
10	94	136384	31	4399	72	72	7200	11743
11	94	442980	30	14766	72	72	7200	22110
12	94	419160	31	13521	72	72	7200	20865
1	95	403424	31	13014	72	72	7200	20358
2	95	383366	28	13692	72	72	7200	21036
3	95	360940	31	11643	72	72	7200	18987
4	95	264078	30	8803	72	72	7200	16147
5	95	206480	31	6661	72	72	7200	14005
6	95	224254	30	7475	72	72	7200	14819
AVERAGES		335803		11048	72	72	7200	18392
TOTALS		4029636	gal/yr					

(1) Source is Fort Stewart Boiler Operating Logs.
WS - Water softener makup water from meter readings.
S - Sulfite (oxygen control) chemical feed makeup water estimate.
M - Morpholine (PH control) chemical feed makeup water estimate.
P - Phophate (calcium control) chemical feed makeup water estimate.

Estimate Distribution System Losses:

	18392	gpd, avg make-up water
-	2475	gpd, avg blowdown water *
	15917	gpd, avg dist system losses

* Boiler blowdown estimate:

	165	gpm
x	5	min/shift
	825	gal/shift
x	3	shift/day
	2475	gal/day

Fort Stewart Central Energy Plant
Energy Consumption
Filename: FS-ENRGY.WQ1

Month	Yr	Wood Tons (1)	Wood MBtu (2)	Wood Cost (2)	#2 Oil Gals (1)	#2 Oil MBtu (3)	#2 Oil Cost (3)	Used Oil Gals (4)	Used Oil MBtu (5)	Used Oil Cost (5)	N.Gas CuFt (1)	N.Gas MBtu (6)	N.Gas Cost (6)	Total MBtu	Total Cost
7	94	6052	74137	65483	75497	10645	46808	0	0	0	5572730	5701	18563	90483	130854
8	94	8169	100070	88389	13822	1949	8570	12956	1749	0	874295	894	2878	104662	99836
9	94	4969	60870	53765	40667	5734	25214	17703	2390	0	352500	361	1056	69355	80034
10	94	3947	48351	42707	42608	6008	26417	18775	2535	0	598230	611	1790	57504	70913
11	94	5000	61250	54100	15884	2240	9848	24298	3280	0	1082030	1107	3488	67877	67436
12	94	6631	81232	71749	22257	3138	13799	9470	1278	0	1366090	1398	4363	87046	89912
1	95	6100	74726	66003	39741	5603	24639	8891	1200	0	1027820	1049	3199	82579	93841
2	95	5024	61544	54360	110411	15568	68455	13181	1779	0	1159730	1186	3368	80078	126182
3	95	5723	70107	61923	19404	2736	12030	11576	1563	0	518890	530	1463	74935	75417
4	95	1869	22895	20223	550	78	341	0	0	0	12995190	13268	37455	36241	58019
5	95	5322	65195	57584	6525	920	4046	11324	1529	0	550120	563	1724	68207	63354
6	95	4768	58408	51590	11466	1617	7109	5476	739	0	2081740	2128	6435	62892	65134
AVERAGES		5298	64899	57323	33236	4686	20606	11138	1504	0	2348280	2400	7148	73488	85078
TOTALS		63574	778785	687874	398832	56235	247276	133650	18043	0	28179365	28796	85782	881859	1020931
AVG COST			$0.88 /MBtu			$4.40 /MBtu			$0.00 /MBtu			$2.98 /MBtu		$1.16 /MBtu	

(1) Source is Fort Stewart Operating Logs.
(2) Assumes heating value of 6125 btu/lb; cost is $10.82/ton.
(3) Assumes heating value of 141000 btu/gal; cost is $0.62/gal.
(4) Source is monthly Oil Reports prepared at the CEP.
(5) Assumes heating value of 18000 btu/lb, 7.5 lb/gal; no cost.
(6) Uses heating value and cost from utility bills.

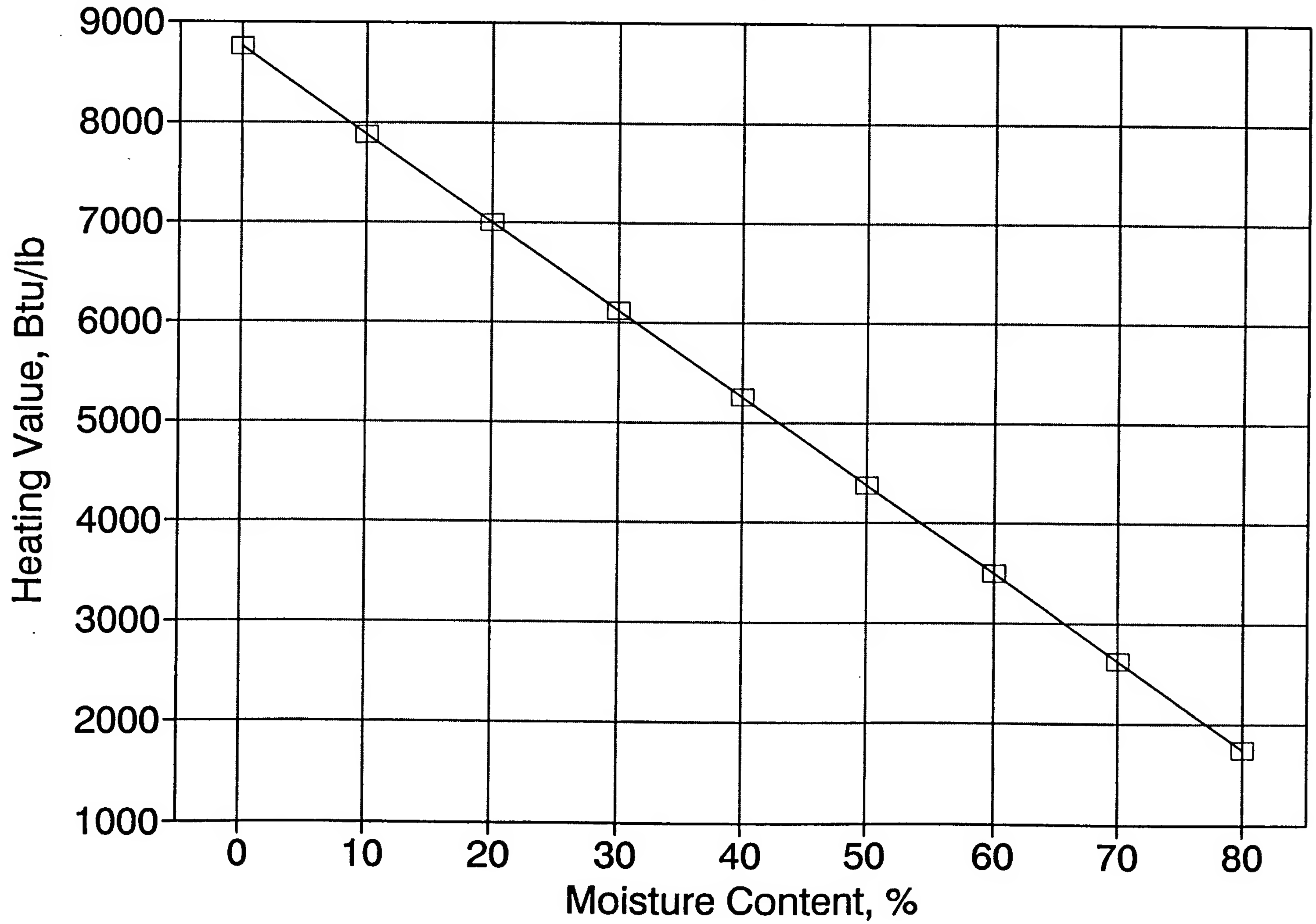
Fort Stewart Central Energy Plant
Energy Production
Filename: FS-ENRGY.WQ1

Month	Yr	Steam Prod k lb (1)	Steam Prod MBtu (2)	Fuel Input MBtu	Avg Eff (3)
7	94	60989	73187	90483	81%
8	94	62837	75404	104662	72%
9	94	44574	53489	69355	77%
10	94	43662	52394	57504	91%
11	94	38255	45906	67877	68%
12	94	49619	59543	87046	68%
1	95	55003	66004	82579	80%
2	95	50776	60931	80078	76%
3	95	45611	54733	74935	73%
4	95	34688	41626	36241	115%
5	95	37774	45329	68207	66%
6	95	40653	48784	62892	78%
AVERAGE		47037	56444	73488	79%
TOTALS		564441	677329	881859	

(1) Source is Fort Stewart Operating Logs.
(2) Total heat content of steam @ 200 psi is 1200 Btu/lb.
(3) Calculated based on input and output data provided.

Available Energy In Wood

Source: Marks Mech Eng Hndbk, Pg 7-11



Heating Value of Wood Fuel
Filename: WOOD-HV.WQ1

Moisture Content, %	Heating Value, Btu/lb	
0	8750	
10	7875	*
20	7000	
30	6125	*
40	5250	*
50	4375	
60	3500	*
70	2625	*
80	1750	

Source: Marks' Handbook for Mechanical Engineers
* These values were extrapoleted.

Repair History & Cost for the HTW Distribution System
Fort Stewart, GA
Filename: FSREPAIR.WQ1

High Temperature System		
Date	Labor Hrs	Cost
04-08-94	5.0	$125
04-11-94	4.0	$100
04-11-94	14.0	$321
04-11-94	3.6	$90
04-13-94	4.6	$135
10-27-94	14.2	$501
11-04-94	1.9	$51
11-17-94	6.0	$2,703
03-01-95	7.0	$175
TOTALS	60.3	$4,202

RS&H

Telephone Call Confirmation

912-767-8931

Project Number 694 1331 002

Local ______ L.D. ______ Placed ______ Rec'd ______ Date 8-14-95

Conversed with Randy Parks Of Ft. Stewart CEP

Regarding HTW Makeup water & chemical treatment at CEP

The mixing tank for feedwater to the wood-fired boiler is used to add Morpholine and phosphate on a continuous basis.

The chemical feed systems for the other boilers are used to add sulphite and morpholine. They estimate the flow from these systems to be about 3 gal/hr each.

The existing makeup water meter does not include any of these chemical feed systems.

The HTW is tested for sulphite and PH. They try to keep the ph between 8.3 and 8.5 (9.3-9.9 is recommended). They try to keep the sulfite between 30 and 40 ppm.

Distribution:

Gas and Liquid Leak Detector

The XLT-16 is revolutionary in that it has both a sonic range to sense liquid leaks and an ultrasonic range to sense gaseous leaks. Both systems are within a very compact control box. Water companies and liquid leak detection professionals can make use of the ultrasonic range when they add air to a water system to cause a distinct "sputtering" at the leak location. Additional uses for the ultrasonic range are: to sense bearing wear, valve flow and seatings, corona discharge, leaking steam traps, and general mechanical trouble shooting. Do not use for detecting leaks of flameable gases.

Features

- Compact control box which can be worn: on the belt; around the neck or over the shoulder with the attachable strap.
- Both sonic and ultrasonic frequency ranges can be sensed for leaks.
- Minimum number of controls for a user-friendly control panel.
- Listening is loudness limited to lessen sudden blasts of uncomfortable sound.
- The "Big Foot" and Hydrophonic Cylinder Probes have three position switches for: (1) mute, (2) momentary on, or (3) locked on.
- The "Big Foot" probe is compact for access in tight areas.
- The carrying case holds all items of the basic set plus the two accessory transducers and a set of spare batteries (not included).

SPECIFICATIONS

Frequency:		**Batteries:**	2 ea. 9 volt (NEDA 1604)
Sonic Range:	Tuneable 100 Hz - 5 KHz Flat Band 100 Hz - 15 KHz	**Battery Life:**	20 hours - intermittent use with standard carbon zinc batteries
Ultrasonic Range:	38 KHz - 42 KHz	**Headset Impedance:**	150 ohms
Listening Frequency for Both Ranges:	Tuneable 100 Hz - 5 KHz Flat Band 100 Hz - 15 KHz	**Weight:**	(In carrying case with both accessory transducers)
Gain:	85 dB	**Size:**	(Carrying case)
Type of Filters:	Tuneable and Flat Band		7-1/4 x 19 x 15 inches (18.4 x 48.2 x 38.1 cm.)

Each Kit Includes:
Complete with carrying case, cushioned headphones, "Big Foot" probe, hydrophonic cylinder probe, three 16" sound rods, four inch sound rod, T-handle, coil cord, cassette recorded training tape, instruction book.

ORDERING INFORMATION

Catalog No.	Model	Description	Price
FI096510	XLT-16	Leak Detector Kit	$1125.00
FI096511	202352	Ultrasonic Probe	$ 95.00
FI096512	202357	Little Foot Probe	$ 225.00
FI096513	202374	25' Extension Cable For Ultrasonic Probe	$ 35.00

A. 10-46

[redacted]

DEDICATED UNIFLOW

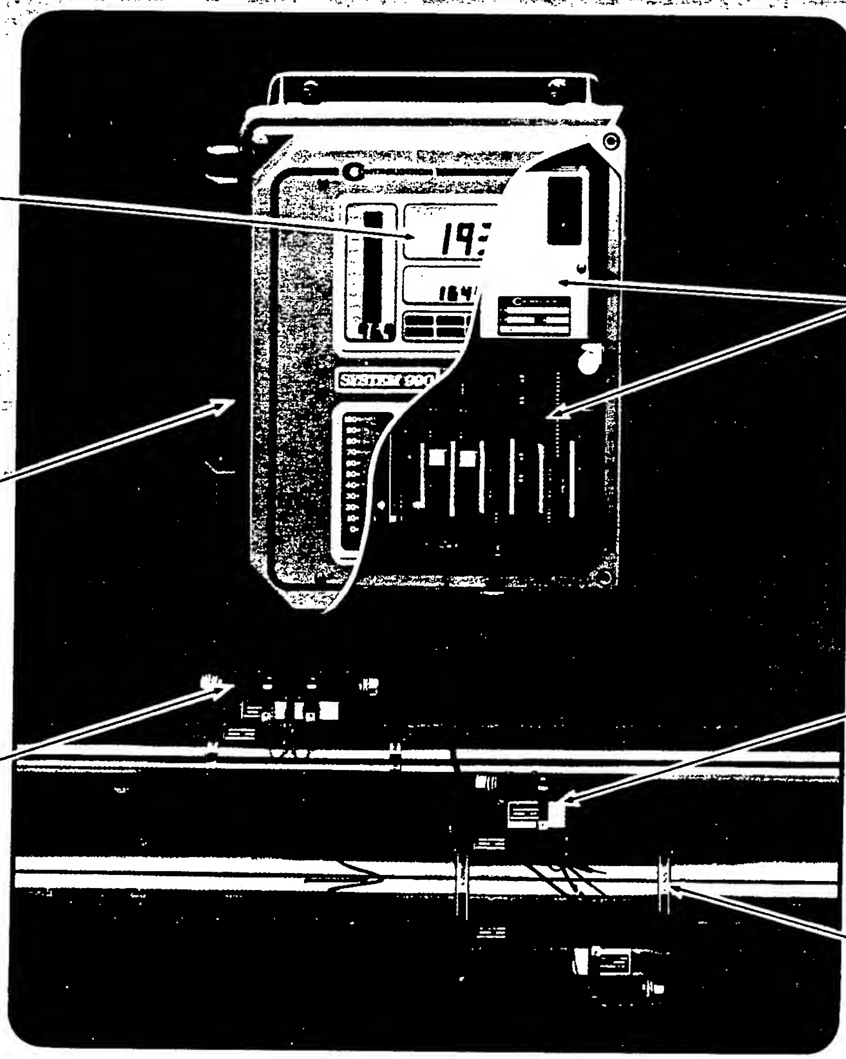
Better Performance, Reliability and Economy than Magmeters, Vortex, Venturis, Turbines and Orifice Plates in Most Applications.

System 990N Uniflow Dedicated NEMA 4X Field Programmable Flow Computer

Large Digit LCD Flow, Total, Analog Barchart and Status Display for each Channel. Dual Channel Graphics Display Optionally Available.

NEMA 4X Case, suitable for essentially all field environments. Intrinsically safe models available.

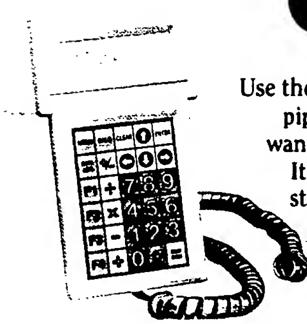
Transducers mount in either Direct or Reflect Mode with PinStop location accuracy. Tracks mount in just minutes (shown in Reflect Mode).



All printed circuit modules, including power supply, plug-in for simple function upgrade or maintenance.

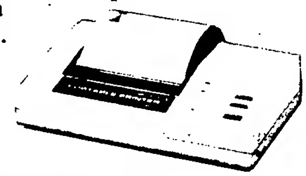
Weatherproof, submersible, NEMA 4 Transducers are intrinsically safe (shown in Direct Mode).

Stainless Steel Track Mounting Straps.



Use the 995T Hand-Held CDU to tell Uniflow the pipe size you want to work on, and what you want it to measure, display, record or control. It takes only minutes to setup a site and install transducers, and only seconds to recall a previously saved site. Used only for Site Setup and Installation, only one 995T Hand-Held CDU is needed to service many individual 990N NEMA 4 Systems.

The 996P Portable Thermal Printer features quiet, high-contrast printing. An RS-232C serial connector is provided for interconnection to a Flow Display Computer. A rechargeable battery allows printing up to 1,500 character lines, before re-charging. This printer is provided in a convenient soft carry case.



A New Standard in Flowmeter Accuracy and Rangeability... Made Possible by UNIFLOW's MultiPulse™ and TransX™ Technology.

HOW UNIFLOW WORKS

Uniflow is a Clamp-On Flowmeter which detects liquid flow rate by its effect on the Transit-Time of Ultrasonic Pulses, alternatively injected through the pipe wall in the upstream and downstream directions by Controlotron's patented ultrastable metallic transducers. Each transmission is not a single pulse, as in prior types of ultrasonic flowmeters, but rather as many as 100 pulses, resulting in the extraordinary sensitivity and calibration stability of Uniflow's MultiPulse™ System.

Uniflow also benefits from its patented TransX™ Transmission System. This is a method by which Uniflow measures the sonic properties of the application's pipe, and automatically optimizes its ultrasonic beam transmission. This gives Uniflow its Universality, the ability to operate on most pipes and most liquids, and its extraordinary immunity to such conditions as liquid aeration and non-homogeneity.

HOW DOES UNIFLOW PERFORM?

EXTRAORDINARY PERFORMANCE

Uniflow's Digital MultiPulse™ System uses no analog circuits, not even phase locked loops. This produces the greatest precision, sensitivity and stability ever achieved in an ultrasonic flowmeter. Flow response is extremely linear over its full ±40 fps range (including zero flow), and is virtually drift free.

Uniflow's SMARTSLEW™ real time data analysis results in extremely low data scatter, even at high slew rate settings. When set for its fastest flow response rate, Uniflow is ideal for flow control or detection of flow transients which would be missed by slower flowmeters. Slower response can be selected, if desired, to avoid reporting flow pulsations which are not of interest.

Uniflow intrinsic calibration accuracy is usually within 1% to 2% in most applications and within 1/4% to 1% if flow calibrated.* Intrinsic repeatability will generally be within 1/2% for most pipe sizes.

SYSTEM 990 UNIFLOW SPECIFICATIONS

APPLICABILITY

LIQUIDS: Any sonically conductive homogeneous liquid of low to moderate aeration (up to 30% maximum).

LIQUID (PIPE) TEMPERATURE: −40°F to +250°F (−40°C to +120° C) Standard
−80°F to +450°F (−60°C to +230° C) Optional

PIPE SIZES: 0.25" to 8" OD (6.35mm to 203.2mm) Specify Group 2 Flow Computer
0.5" to 24" OD (12.7mm to 609.6mm) Specify Group 3 Flow Computer
0.5" to 48" OD (12.7mm to 1219.2mm) Specify Group 4 Flow Computer
0.5" to 216" OD (12.7mm to 5486.4mm) Specify Group 5 Flow Computer
0.5" to 360" OD (12.7mm to 9144mm) Specify Group 6 Flow Computer

PIPE MATERIAL: Any sonically conductive pipe material: Metal, Glass, Plastic, etc.

PIPE WALL THICKNESS: 0.01" to 3.00" (0.25mm to 76.2mm)

LINER MATERIAL: Any sonically conductive material, Glass, Plastic, Cement, etc., intimately bonded to the pipe interior.

LINER THICKNESS: Up to 1" (25.4mm), dependent on material.

FLOW VELOCITY RANGE: ±40 fps (±12.2m/sec), minimum

991 CLAMP-ON TRANSDUCERS

PIPE SIZE RATINGS:

- Group 0: 0.25" to 2" (6.35mm to 50.8mm) pipe OD
- Group 1: 0.5" to 4" (12.7mm to 101.6mm) pipe OD
- Group 2: 1.25" to 8" (31.75mm to 203.2mm) pipe OD
- Group 3: 6" to 24" (152.4mm to 609.6mm) pipe OD
- Group 4: 20" to 48" (508.0mm to 1219.2mm) pipe OD
- Group 5: 36" to 360" (914.4mm to 9144.0mm) pipe OD

RATING: Intrinsically safe. Radiation Resistant and Submersible available.

CONSTRUCTION: Aluminum, stainless steel and special alloy or plastic.

CONNECTORS: Condulet for NEMA 4, BNC for Portable.

992 MOUNTING TRACKS

- Available in Direct and Reflect Mounting for all transducer sizes in standard pipe diameter ranges.
- PinStop transducer spacing standard for all models.

994 FLOW COMPUTER

- **POWER:** 100/120 or 220/240 VAC, 1ϕ, 40 VA
  9 to 36 VDC, 20W, portable systems available with internal battery
- **TEMPERATURE:** −5°F to +115°F (−20°C to +45°C)
  (except for Graphics Models)
- **SIZE:** 10.5" W, 9" D, 13" H (266.7mm W, 228.6mm D, 330.2mm H)
- **WEIGHT:** 12.8 pounds (5.8 kilograms), (without Battery)
- **RATING:** Intrinsically safe. NEMA 4X with cover closed.
- **MODULES:** Plug-In, Interchangeable W/O special tools
- **RANGES:** Group 2: Transducer Sizes 0, 1 and 2
  Group 3: Transducer Sizes 1, 2 and 3
  Group 4: Transducer Sizes 1, 2, 3 and 4
  Groups 5 & 6: Transducer Sizes 1, 2, 3, 4 and 5

994 PERFORMANCE (Standard Conditions)*

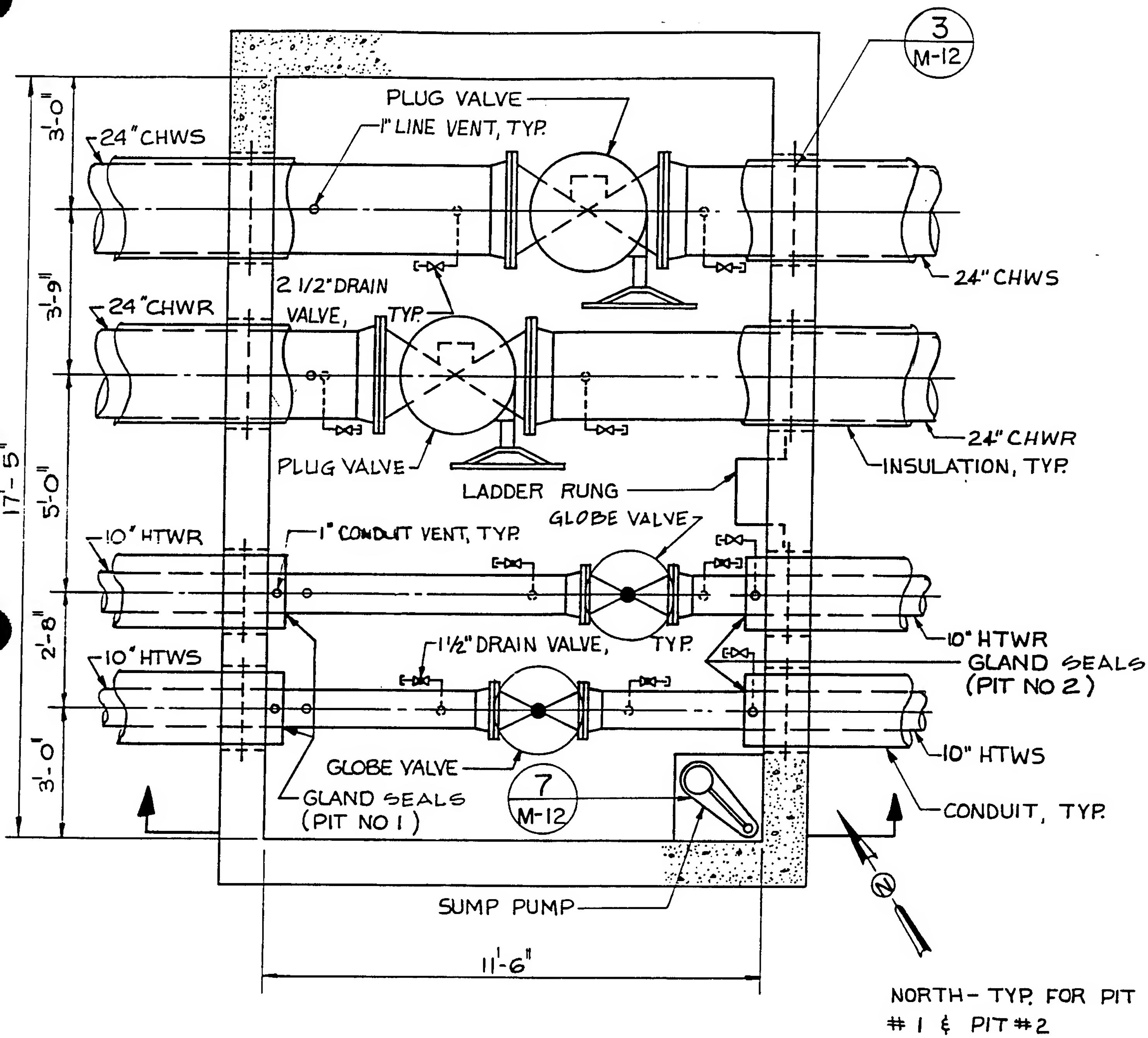
- **SENSITIVITY:** 0.001 fps (0.3mm/sec) at any flow rate including zero.
- **LINEARITY:** 0.003 fps (0.9mm/sec) under standard conditions.
- **DATA UPDATE RATE:** 10 Hz
- **SLEW RATE:** 0.1 to 40 ft/sec/sec (0.03 to 12.2m/sec/sec), (settable)
- **FLOW PROFILE COMPENSATION:** Reynold's Number 0 to 10^7
- **ZERO DRIFT STABILITY:** 0.02 fps (6mm/sec) for transducer sizes 0 to 2
  0.01 fps (3mm/sec) for transducer sizes 3 to 5

995 HAND HELD CONTROL/DISPLAY TERMINAL

- 4 row, 80 character LCD
- 30 Keys, Numeric or Function identified

* Submit Application Form for estimate of performance under specific application conditions. For statement of accuracy, site survey is required.

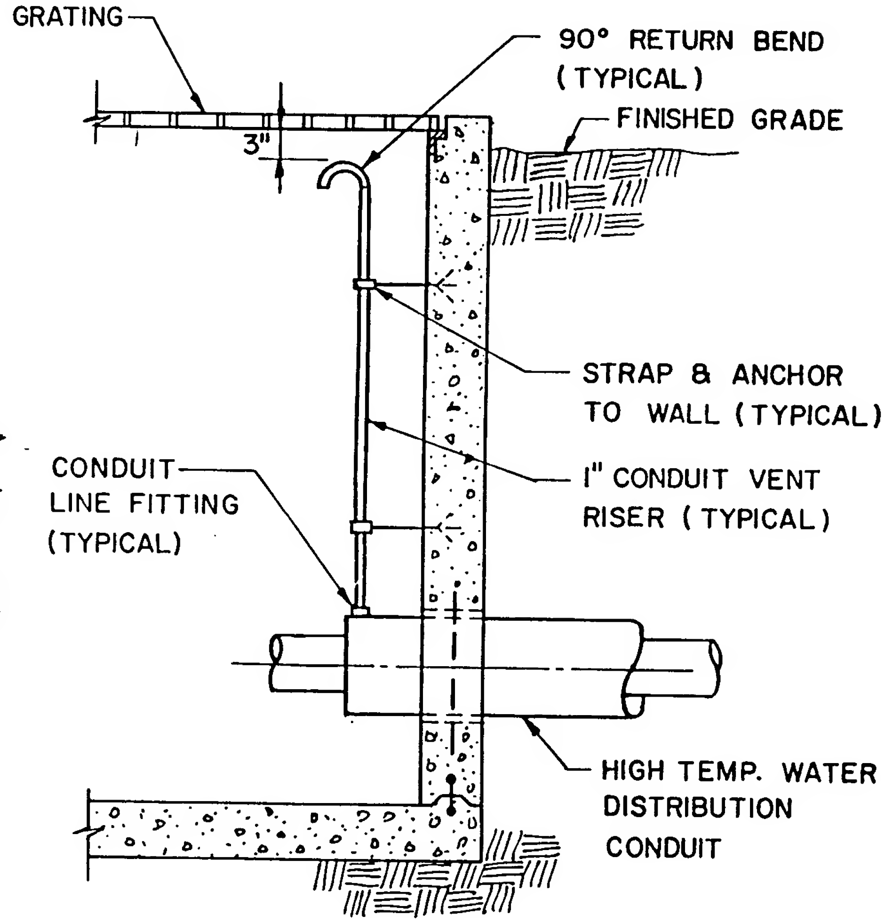
A.10-48



3
M-12
PLUG VALVE
1" LINE VENT, TYP.
24" CHWS
24" CHWS
2 1/2" DRAIN VALVE, TYP.
24" CHWR
24" CHWR
PLUG VALVE
INSULATION, TYP.
LADDER RUNG
GLOBE VALVE
1" CONDUIT VENT, TYP.
10" HTWR
10" HTWR
1½" DRAIN VALVE, TYP.
GLAND SEALS (PIT NO 2)
10" HTWS
10" HTWS
GLOBE VALVE
GLAND SEALS (PIT NO 1)
7
M-12
CONDUIT, TYP.
SUMP PUMP
3'-0"
3'-9"
5'-0"
2'-8"
3'-0"
17'-5"
11'-6"
N
NORTH - TYP. FOR PIT # 1 & PIT # 2

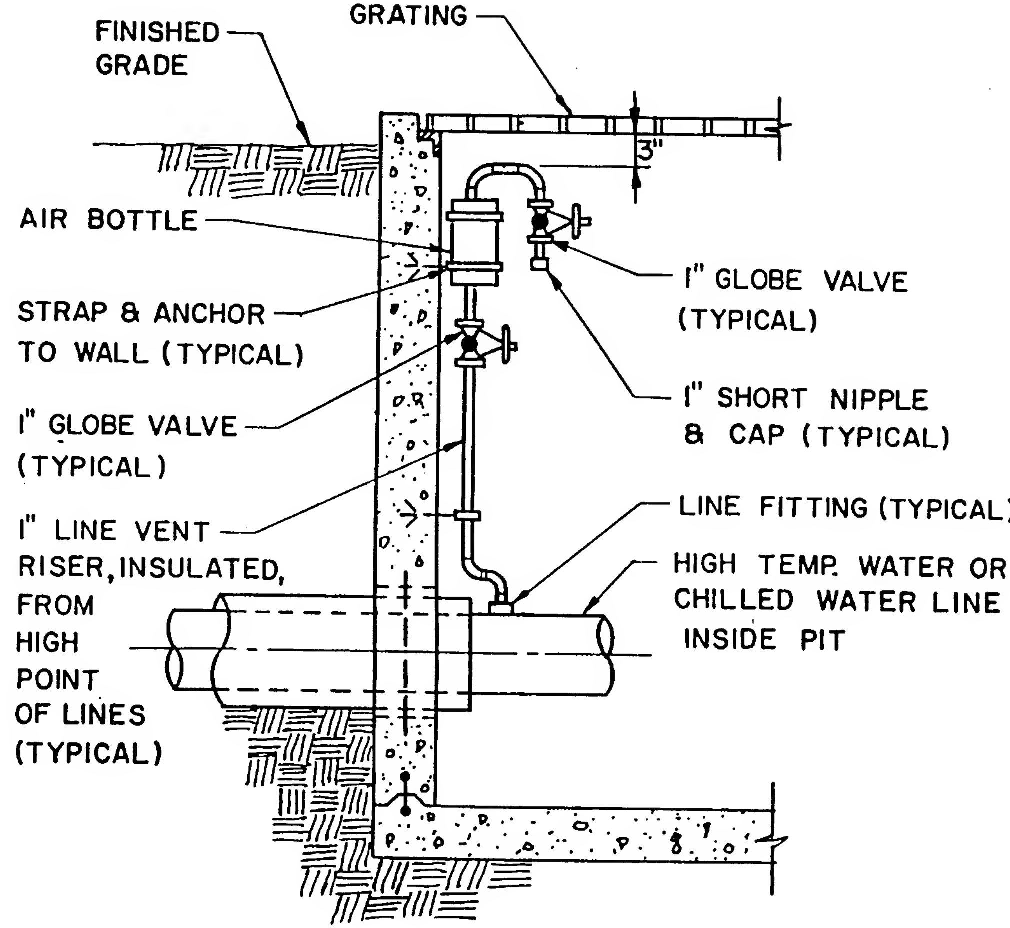
VALVE PIT

A.10-50



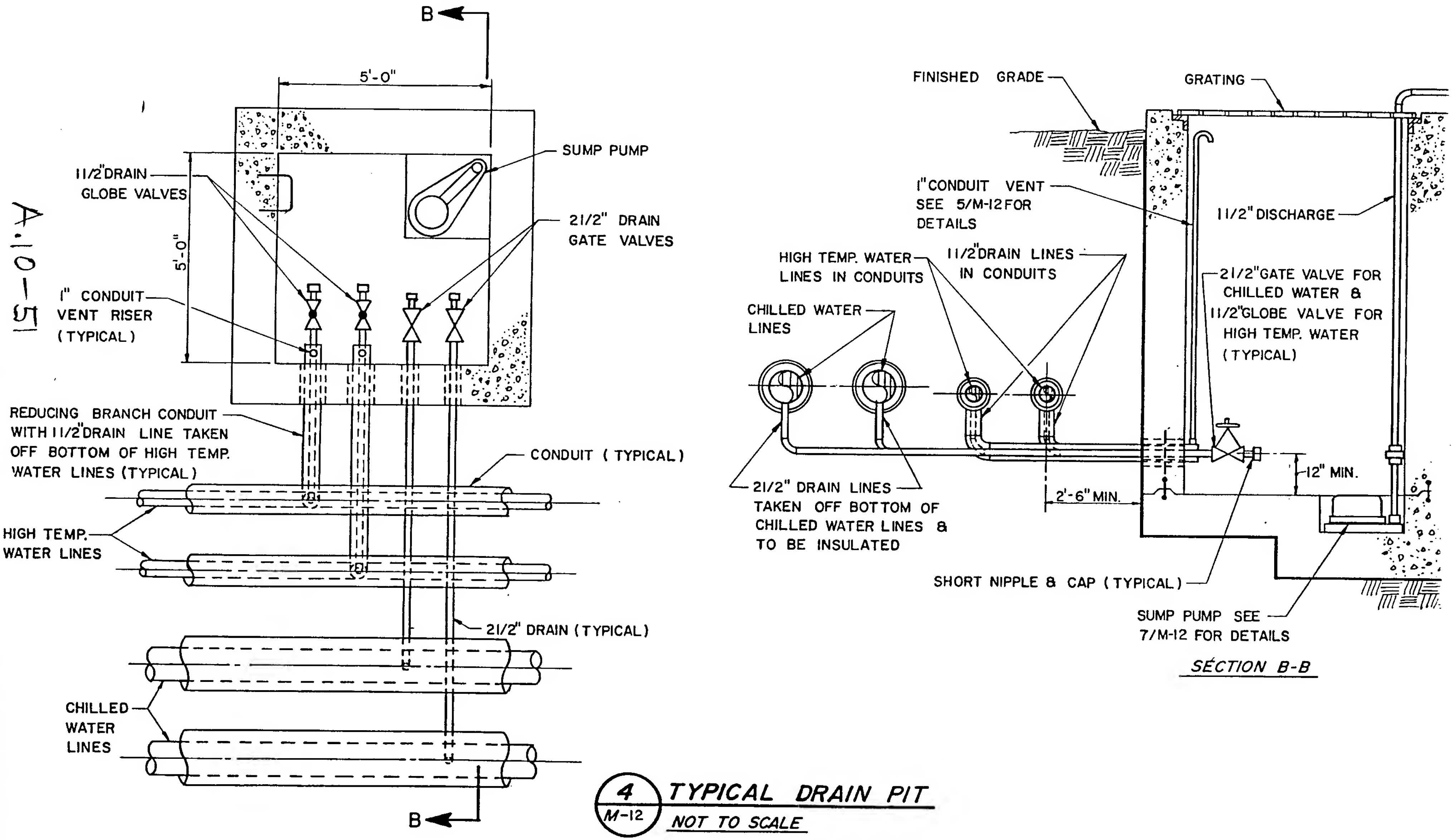
5 / M-12 **TYPICAL CONDUIT VENT DETAILS**

NOT TO SCALE



6 / M-12 **TYPICAL LINE VENT RISER & AIR BOTTLE DETAILS**

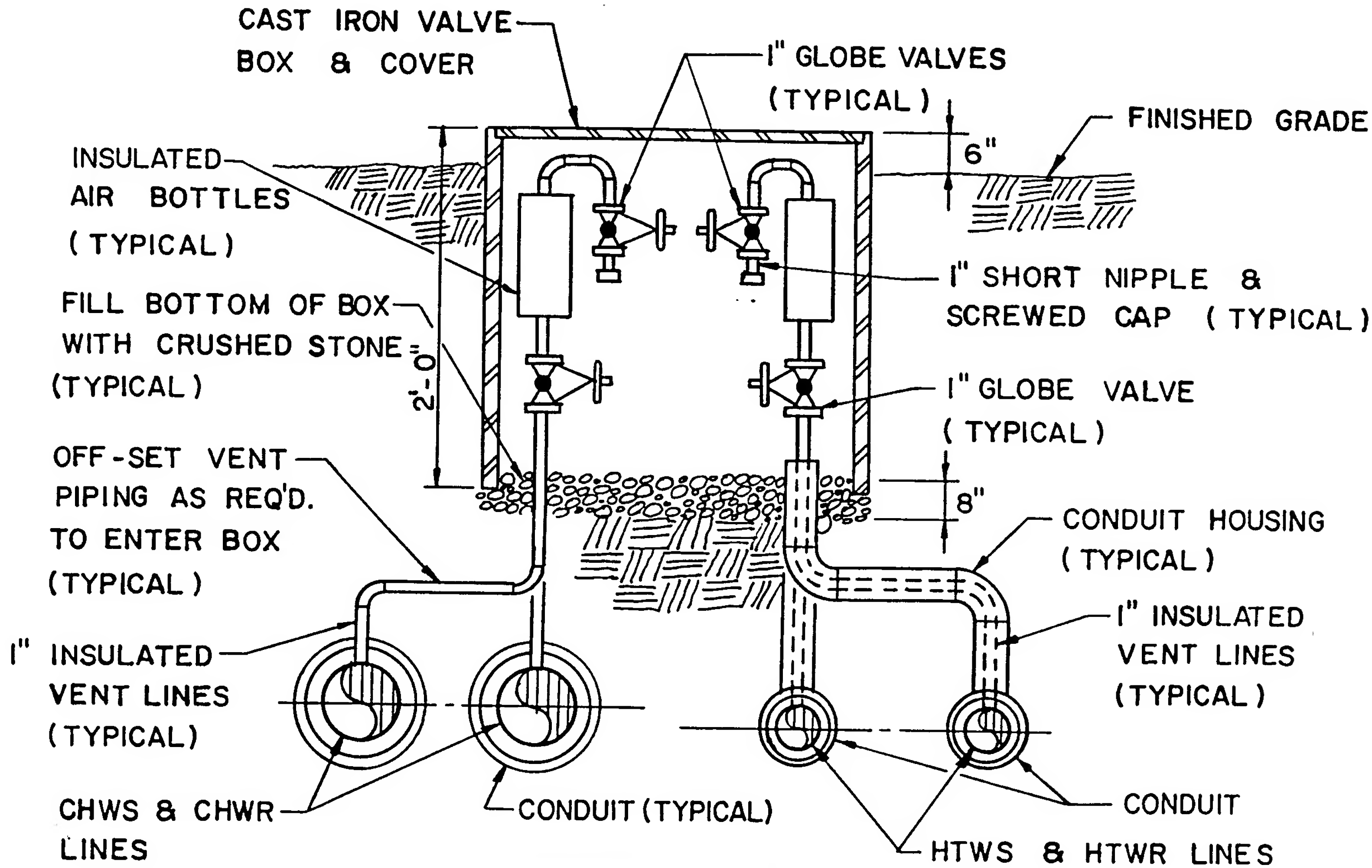
NOT TO SCALE



4 / M-12 **TYPICAL DRAIN PIT**

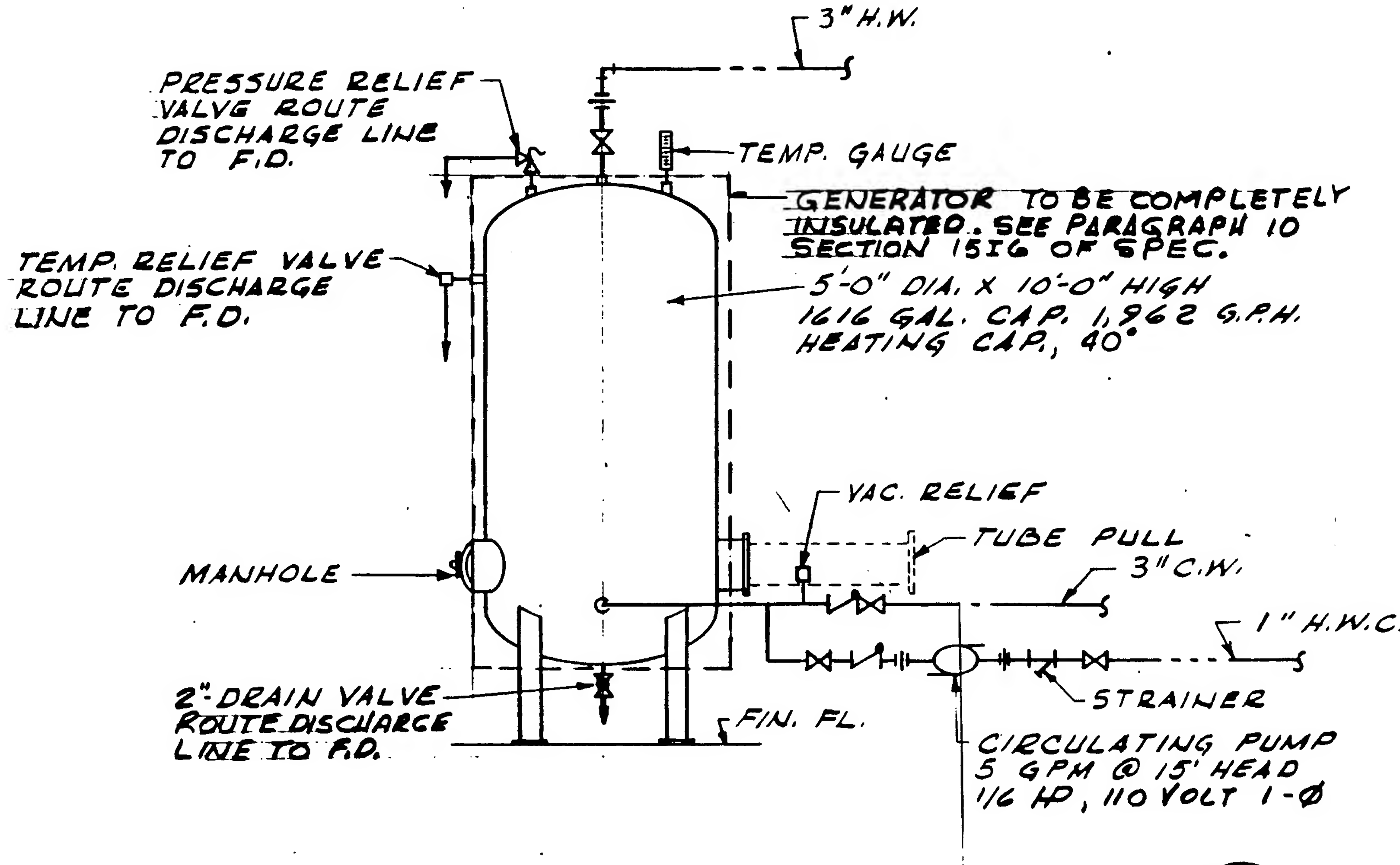
NOT TO SCALE

A.10-51



SECTION A-A

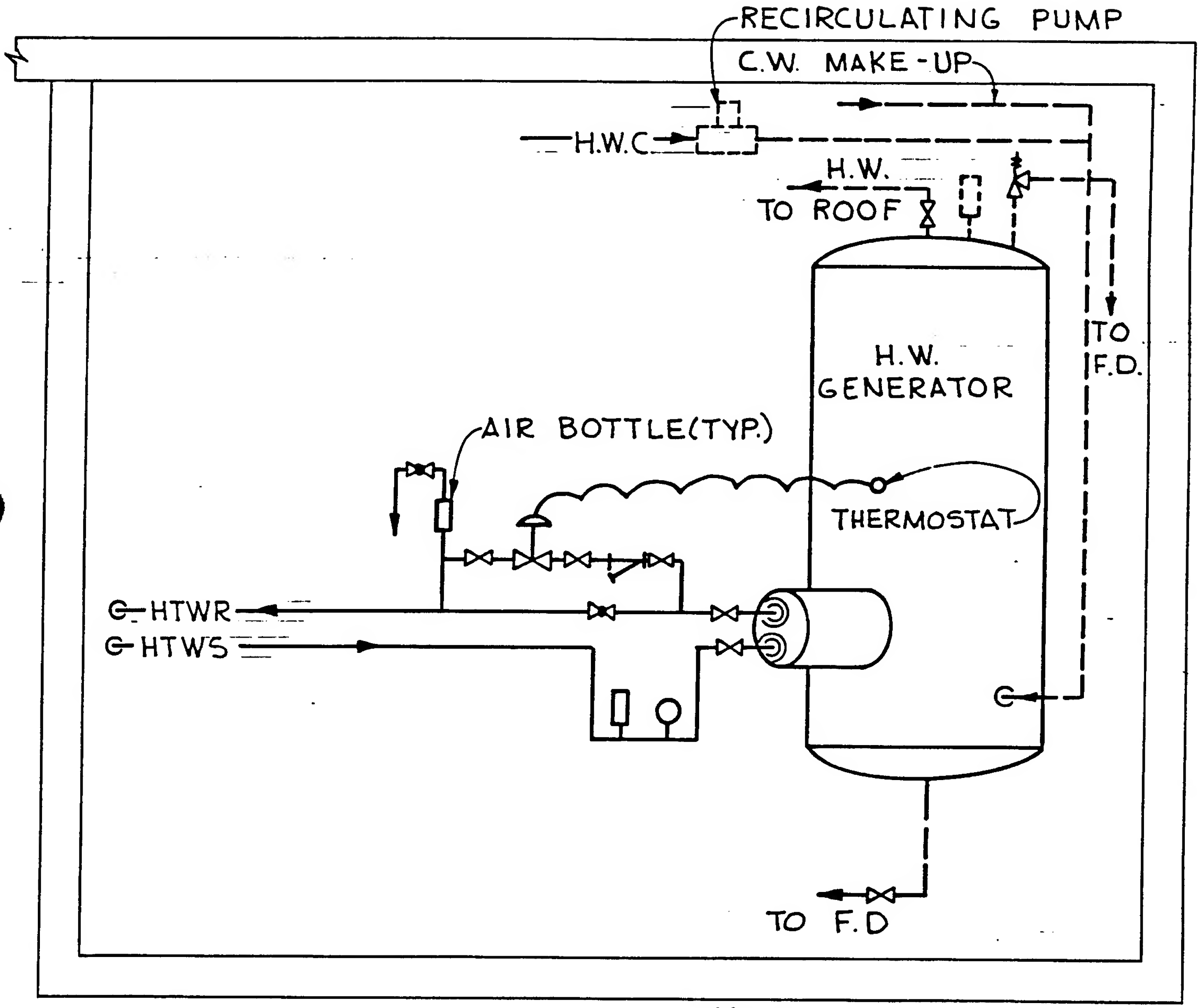
VALVE BOX



DETAIL WATER GENERATOR PIPING

A
M-10 | M-9

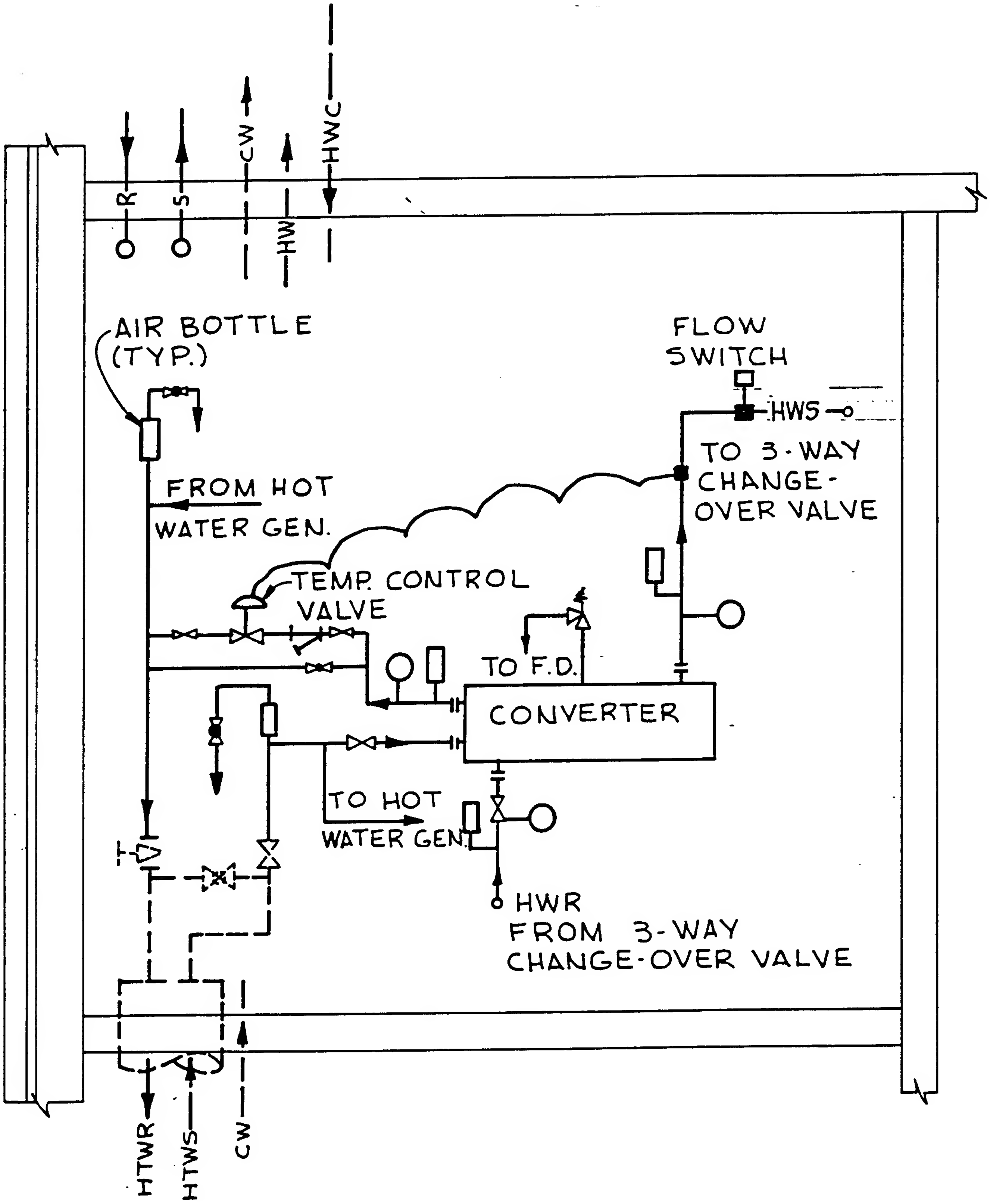
NOT TO SCALE



NOTE:
USE FLANGED CONNECTIONS
WATER CONNECTIONS TO H.

SECTION 3 M-14 M-14

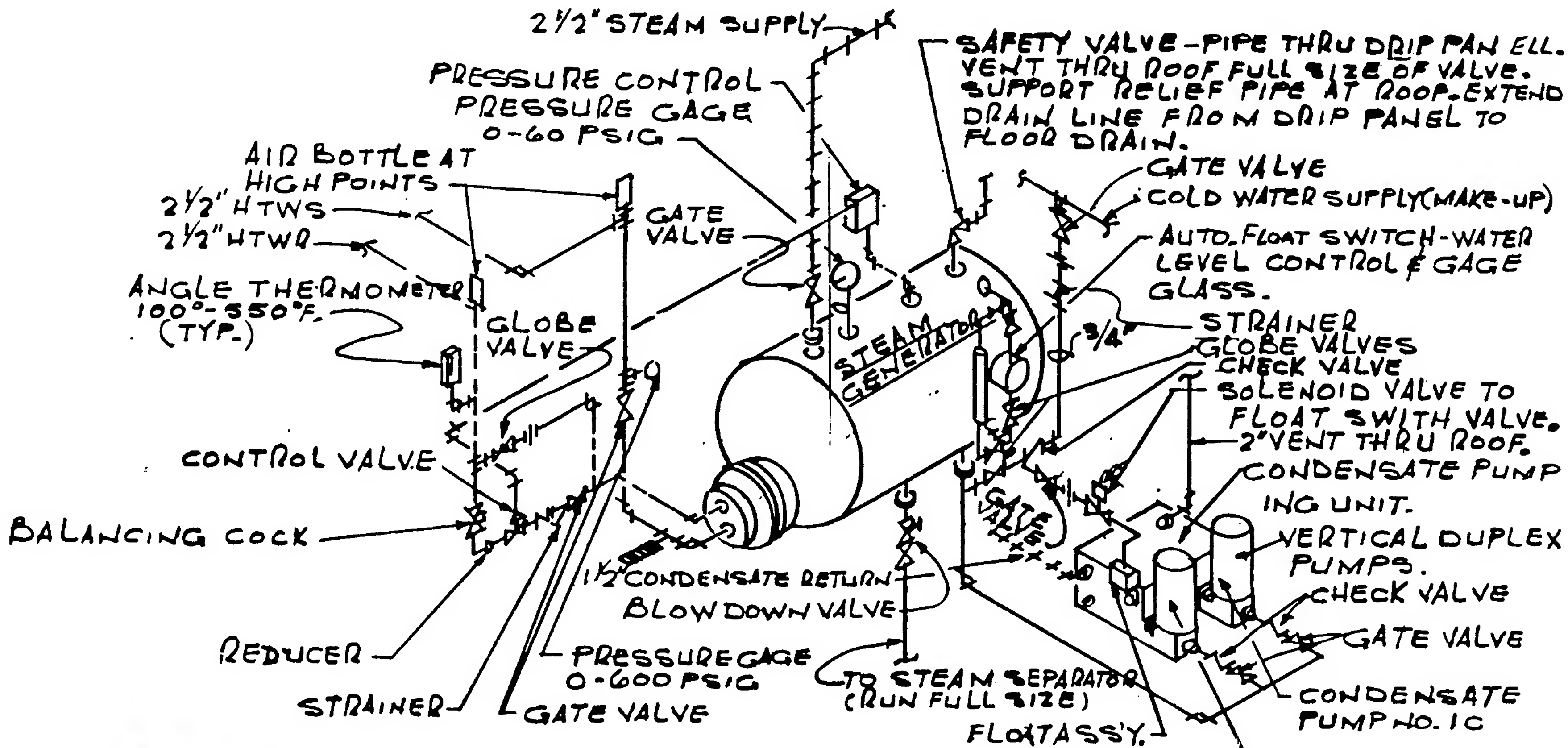
A.10-54 SCALE: $\frac{1}{2}$" = 1'-0"



SECTION

A.10-55

SCALE: $\frac{1}{2}$" = 1'-0"



SCEMATIC - PIPING ARRANGEMENT
H.T.W. STEAM GENERATOR
NOT TO SCALE